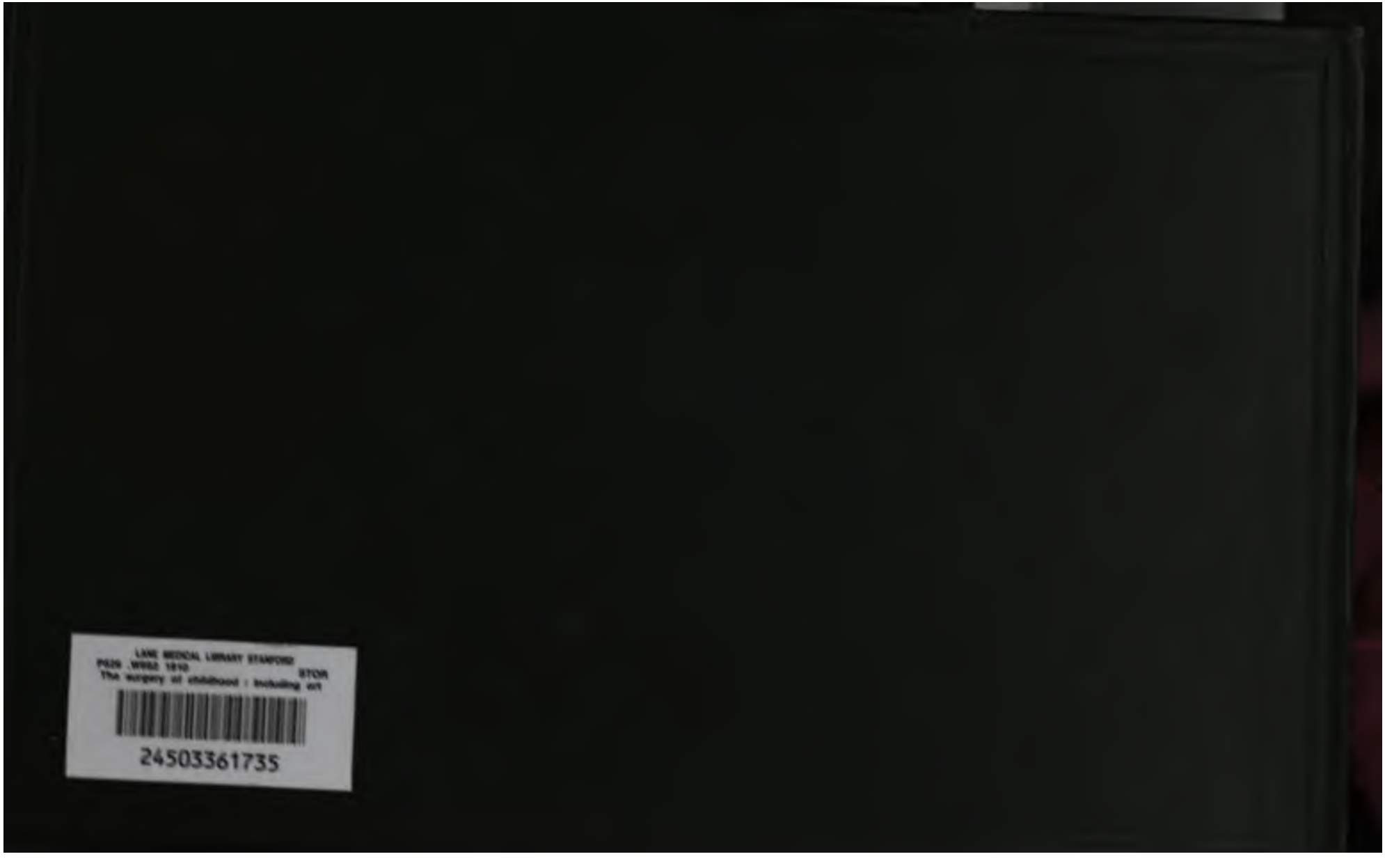

A. Tubercle containing giant cells. *B*. Cartilage. *C*. Old tuberculous tissue. *D*. Bone trabeculæ. The tissue designated by *C* is a portion of another tubercle and contains round cells, endothelioid cells, and some degenerated cartilage cells; all a result of the tuberculous invasion,—in fact, an older process than that containing the giant cells. The tuberculous process in this particular case extended from the bone toward the cartilage. The nearer to the cartilage the more recent the lesion. (Major.)

THE

SURGERY OF CHILDHOOD

INCLUDING

ORTHOPAEDIC SURGERY

BY

DE FOREST WILLARD, A.M., M.D. (Univ. of Pa.), PH.D.

Professor of Orthopaedic Surgery University of Pennsylvania; Surgeon (26 years) to the Presbyterian Hospital; Surgeon-in-Chief Widener Industrial School for Crippled Children; Ex-President American Surgical Association, American Orthopaedic Association, Philadelphia Academy of Surgery, Philadelphia County Medical Society; Ex-Chairman Surgical Section American Medical Association, Fellow Philadelphia College of Physicians, etc., etc

WITH 712 ILLUSTRATIONS—INCLUDING 17 IN COLORS

"Thyngs that he hath fyrst proved and trewly founde by his awne dayly exercysynge"

MAYSTER JHEROME.

PHILADELPHIA & LONDON

J. B. LIPPINCOTT COMPANY

Printed by J. B. Lippincott Company
The Washington Square Press, Philadelphia, U.S.A.

To the Memory

of

D. HAYES AGNEW, M.D., LL.D.

WHO ADDED TO HIS CLEAR TEACHING, SOUND JUDGMENT AND SKILFUL MANIPULATION, THE HIGHEST AND MOST ENNOBLING PROFESSIONAL IDEALS OF HONESTY AND THE TRUEST CHRISTIAN CHARACTER:

AND

TO MY PROFESSIONAL FRIENDS AND STUDENTS

Greetings

PREFACE

TREATISES upon General Surgery are many and a number of excellent volumes on Orthopaedic Surgery have been published, but works devoted to the Surgical Conditions of Childhood are few.

The effect of infancy and youth upon abnormal conditions warrants separate consideration especially as regards diagnosis, prognosis and treatment. In the new-born the rapid formative changes of embryologic development are still active and during the first decade of life constant change is to be expected, a fact that has an important influence upon the examination and treatment of children.

At birth the bones are soft and readily molded and manipulative treatment of malformations can be commenced at once. Manual correction of deformities of arms, fingers, legs, feet, neck and ears can be accomplished with slight force and without giving pain. While infants bear the loss of blood badly, yet their recovery is rapid as soon as the shock of a primary operation is over. In adolescence even up to the age of fifteen or twenty the recuperative power from the vigor of growth and repair is so great that it can be utilized with confidence by the surgeon.

One of the principal objects of the book is to induce the earlier examination and recognition of the diseases of childhood, since irreparable damage frequently follows through delay in investigation or treatment by the attending physician or surgeon.

For years the author has been urged to put in permanent form his personal surgical experiences, but pressure of other duties has exhausted the time and strength necessary to the accomplishment of this work.

To condense into a single volume all the subjects shown in the table of contents has required careful elimination. The endeavor has been to select and present methods of diagnosis and treatment that by long experience have proved to be of rational service, or as Mayster Jherome in the year 1525 quaintly put it, that "he hath fyrst proved and trewly founde by his awne dayly exercysynge."

The subjects discussed are classified as seemed most practical and convenient for the reader and student, arranging allied subjects or connected regions of the body in apposition. The illustrations have been largely drawn from photographs and skiagrams of patients in the author's practice. Extended histories of cases and bulky statistics have been avoided except where the latter seemed useful in their influence upon treatment or prognosis. Unless statistics are compiled from a large number of cases and from many observers they are unreliable as to results because reports of the successful cases will be largely disproportionate to the unreported and the unsuccessful. Again, a single operator may have a hundred favorable results and then have his record followed by five consecutive fatalities. Surgeons have been known who upon an experience of a single case have published positive statements.

PREFACE.

he importance of the practical, clinical examination of each mphasized, yet the systematic use is urged of accurate and thods of investigation by instruments of precision. The valuace rendered by well-equipped laboratories of X-ray photogology, bacteriology and physiologic chemistry have not been as corroborative or additional proofs in diagnosis; nor have gienic, gymnastic, mechanical, electrical or other aids to cure en. Blood, urine, pus and serum, as well as removed solid eed laboratory study. Cryoscopy and the differential count of re of great service, but in addition to research and investigation of the present day needs to learn that accurate cerebration is nterpret and apply the results obtained by any or all of these to the understanding of disease.

tudy of living anatomy is of great importance, many Röntgen- been introduced; although they are but shadows they are helpful in demonstrating the relation of living hard and soft body and in aiding accurate diagnosis.

volume are answered some of the many questions that have the author in the consultation room and in the amphitheatre years of teaching.

k has been prepared fragmentarily in moments snatched from f active professional life and repetitions have been necessary n written not so much for the physician who will read the book ly as for the busy practitioner who will consult it upon a parct.

ume is submitted with the hope that the suggestions may be l to the Profession that has ever dealt all too kindly with the

AUTHOR.

hanks are due to my son, Dr. De Forest Porter Willard, for valuce while the work was passing through the press; also to my rs. Caroline G. Peeler, for her careful attention to details of the Photographs have been supplied by Dr. J. M. Spellissy, Dr. and Miss Anna S. Kite. Valuable suggestions in regard to bacy have been made by Dr. Benjamin A. Thomas and illustrations s have been furnished by Mr. Louis Schmidt. Credit is given in o authors from whose works illustrations have been selected and ssible references in the text have been traced to their sources. sincere acknowledgments are made, and also to the publishers, cott Co., for the exceptionally fine character of the volume.

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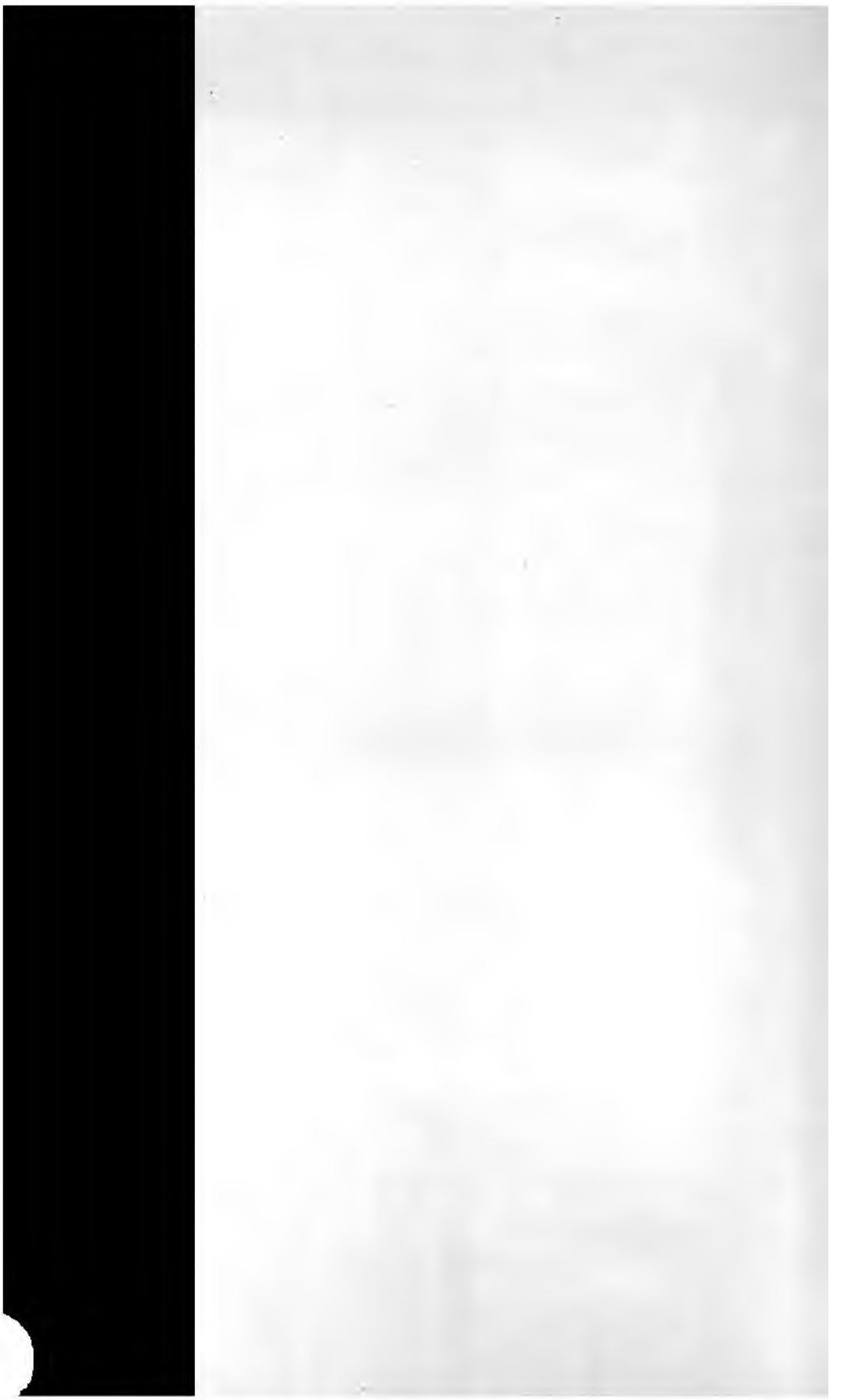

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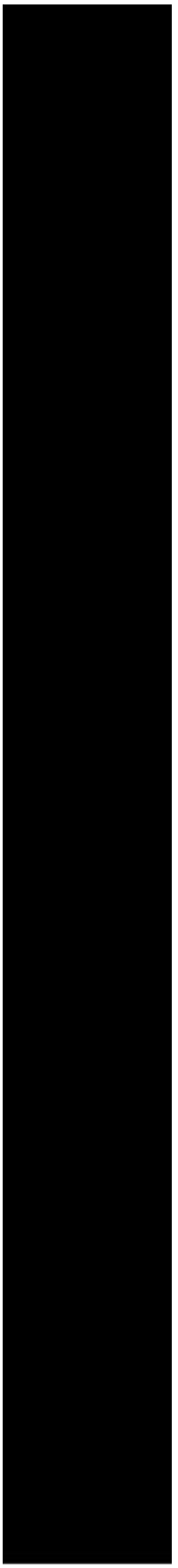

SURGERY OF CHILDHOOD

CHAPTER I.

GENERAL SURGICAL CONSIDERATIONS.

THE SURGERY OF CHILDHOOD differs in many respects from the surgery of adult life and requires special consideration both by the general surgeon and the family physician. The paediatric surgeon must necessarily depend largely upon objective symptoms for his conclusions, consequently he must possess a high degree of acute observation, intelligence and discrimination in arriving at a diagnosis and in supervising the treatment.

The best surgeon will be the one with the widest experience of years in the care and treatment of every class of cases. Surgery, internal medicine, hygiene, physiologic chemistry, and the laboratory can never be wisely divorced. Each and all have their full influence upon the scientific diagnosis and treatment of diseased conditions.

The human body is a complex anatomical system and the more one studies the interdependence of every organ and tissue the more obligatory becomes the broad intelligent view of the surgeon who has learned in the school of experience that the entire human system must be regarded.

Important and necessary as is the work of the specialist in discovering and applying the advances of science, a narrow vision that perceives only a single important organ must fall far short of final success. Every year scientific investigation is demonstrating the absolute importance in the human economy of small organs like the parathyroids, adrenals and the pituitary body. Ovaries that a few years since were recklessly sacrificed are now conserved as essential from childhood to the final and highest creation—the perfect woman.

The first thought of the surgeon should ever be that his patient must be brought back as nearly as possible to a condition of normal health. To this end, eyes must be trained to observe, hands educated to feel, ears to hear, nose to detect—in fact every sense must be highly developed to ascertain the various elements that tend to make a successful surgeon. More important still is the alert brain to interpret the impressions received through the senses. Added to all is that rare gift—common sense—a gift so seldom possessed and yet so essential for the proper understanding and the skilful management of patients young or old. That wise Master in Surgery, D. Hayes Agnew, said: "The successful management of disease

FIG. 1.—Photograph of girl baby, 7 months old. Topographical relations of some of the organs and landmarks in front.—1, left nipple pushed upwards by the mother's hand; 2, position of apex-beat of the heart; 3, ensiform cartilage; 4, position of stomach in contact with abdominal wall; 5, umbilicus; 6, position of the bladder; 7, fatty fold noticeable before child can walk; 8, position of the base of the heart; 9, diaphragm; 10, lower margin of costal cartilages; 11, lower border of the liver; 12, position of the vermiform appendix; 13, position of the sigmoid flexure of the colon in the infant. (McClellan, Keating's Diseases of Children.)

FIG. 2.—Photograph of baby 7 months old. Topographical relations of some of the organs and landmarks behind.—1, inferior angle of right scapula; 2, lower point of liver-dulness; 3, position of right kidney; 4, inferior angle of left scapula; 5, left iliac crest; 6, position of great trochanter. (McClellan.)

its distinct recognition. To determine with certainty the malady by stripping away all disguises, involves well-trained servation and an enlightened judgment. The senses must be ucated and the mind trained to precise logical methods of Especially are these qualities required in the treatment of en.

le the organs of childhood may be expected to be in a healthy The acquired vices resulting from long misuse or abuse of the e absent, thus rendering great assistance in the battle against ie natural hopefulness of childhood and the absence of any to the future, render the prognosis exceedingly favorable. resiliency of the child is marked and the surgeon may con- e for recovery even under apparently adverse conditions. A ses such wonderful powers of recuperation and repair that as depressing agent is removed he will rebound with the elasticity ber.

first months after birth the embryonic processes are still active, are soft and elastic, and in these months many congenital de- corrected simply by gentle well-directed manipulations.

ital defects are frequently neglected by family physicians and allowed to continue its crippled condition far beyond the ad- e for operation. The carelessly considered advice "wait" and have made many permanent cripples. Malformations like im- ctum of course demand immediate operation. Extensive hare- late, etc., should be operated early. After the second month, functions are well established and before teething has begun, ations can be most advantageously performed.

ANATOMY.

ceedingly important that the paediatric surgeon should acquaint the anatomy of the child (Fig. 1). The teaching in this respect ery imperfect, since routine dissections are all made upon adults linary graduate has no knowledge whatever of children's anat- 2 and 3). The exceeding smallness of the organs and tissues will e to one who has not dissected infants and small children. The narrow diameter of the trachea, for instance, readily accounts at interference to respiration as seen in laryngeal diphtheria. , when an Interne, made it a rule, at every autopsy of a child, y note the size, relative position and anatomical bearings of n in the body.

RÖNTGEN RAY ANATOMY.

the introduction of the X-ray a new branch of study has been the surgeon, and a knowledge of normal radiographic anatomy e absolutely essential.

uthor presents in the following pages a number of illustrations es and joints of children in order to show the undeveloped char- e epiphyses, and the errors that may readily occur in the inter-

FIG. 3.—Ossification of humerus. *A*, just after birth; *B*, in the first year; *C*, at 3 years; *C'*, sections of ends of preceding; *D*, at 5 years; *E*, at about 13 years; *E'*, sections of ends of preceding; *F*, at about 16; *F'*, sections of ends of preceding. *a*, centre for shaft; *b*, for head; *c*, for capitellum and part of trochlea; *d*, for greater tuberosity; *e*, for head and tuberosities in transverse section; *f*, for internal condyle; *g*, for inner part of trochlea. *G*, upper end of humerus, showing epiphyseal line on surface; *H*, in section; *I*, upper end of humerus, showing cupping of epiphysis to receive the pointed end of diaphysis. (Piersol's Anatomy.)

pretation of these shadowgrams (Figs. 4, 5, 6). A normal epiphyseal line may be readily diagnosed as a fracture by a surgeon inexperienced in reading these skiagrams. The preponderance of the cartilaginous tissues in the region of the joints has led to many false diagnoses, and no surgeon should fail to carefully study each of his plates before arriving at a conclusion (Fig. 7). The judgment of a Röntgen expert is often of great assistance, as his trained eye will detect slight shadows that would otherwise be unnoticed.

FIG. 4.—Normal hand of child two years of age. Epiphyses and carpus still cartilaginous. Centres of ossification appearing.

An X-ray examination is helpful in diagnosis in a large number of cases, not only in bone and joint lesions, fractures, deformities, and metallic foreign bodies, but also in lung and heart lesions. (For X-ray in Tuberculosis and in Orthopaedic Surgery, see pp. 230, 374.) Too much reliance, however, should not be placed upon such a representation, since it is but a shadowgram, and shadows are deceptive (Fig. 8).

A diagnosis by X-ray alone is very misleading, especially to one unaccustomed to carefully interpreting the representation as delineated in the plate or fluoroscope (Fig. 9). Large surgical knowledge and a thorough

FIG. 5.—Normal hands, with epiphyses of radius and of ulna still ununited. Not to be mistaken for fracture. Boy, 7 years.

appreciation of all the clinical conditions are important, coupled with accurate technic by the radiologist and a careful translation of the shadowgram (Fig. 10). The shadow of a man upon the ground will

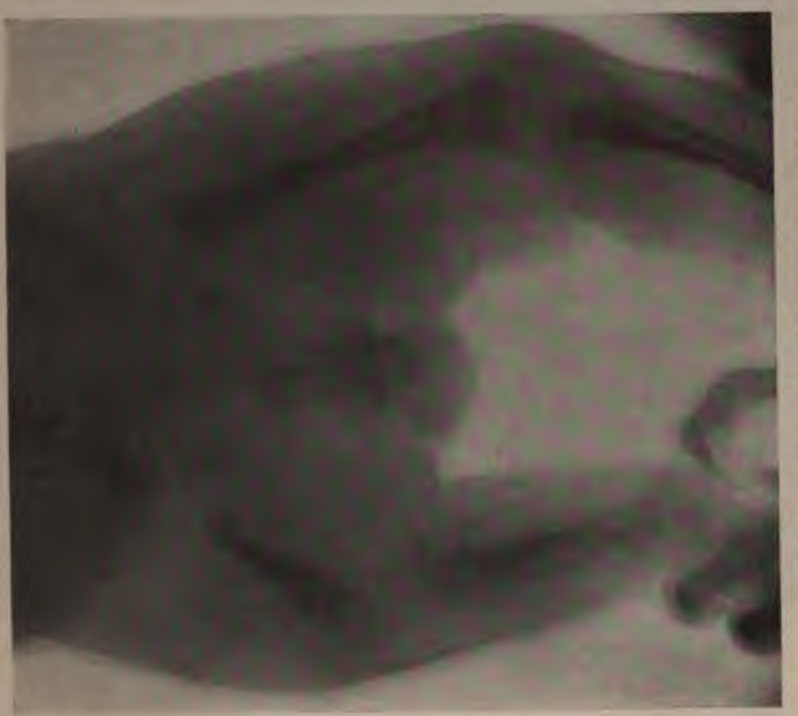

FIG. 7.—Girl, 6 months old. One femur normal, the other deficient.

FIG. 8.—Skiagram of fetus; vessels injected with mercury. (Piersol's Anatomy.)

FIG. 8.—Normal thorax and shoulders of child of 2 years. Epiphyses of humeri ununited to shafts and cartilaginous. Ribs and vertebræ normal. Note shadow of heart.

FIG. 9. — Tibial and calcaneal epiphyses normal. Boy of 8. Ankle-joint operated to secure ankylosis in paralysis.

FIG. 10. — Normal knee. Boy, 5 years of age. Epiphyses still separate from diaphyses.

FIG. 11.—Normal hip-joints. Child aged 3 years.

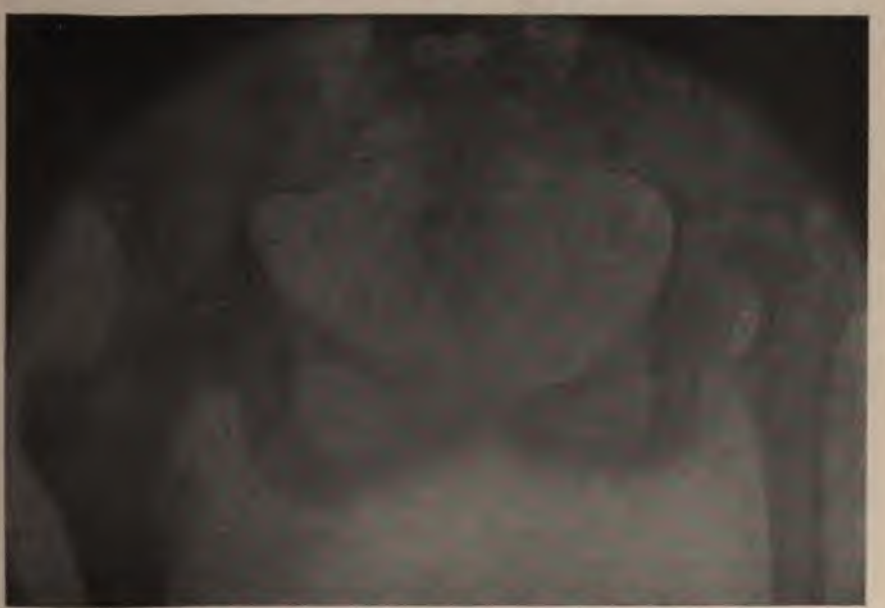

FIG. 12.—Girl of 12 years. One hip-joint normal; the other, head and neck of femur destroyed by hip disease.

ore of different aspects, varying with the position of the sun ndividual. It is very important for the surgeon to relearn his omy from the radiographic standpoint, since many of the nor- s to the untrained eye may be interpreted as pathological In children the great preponderance of cartilaginous tissue in ead to many an error, especially about epiphyses, joints and ssification, unless due consideration is given to the age of the ;. 12). Many so-called sprains are accompanied by fracture, e to employ the Röntgen ray in all such injuries near a joint. f the tarsus and of the carpus are especially difficult of diag- nical symptoms, as the injury is often a severe one and great l pain are usually present (Fractures, p. 363).

n Ray Therapy.—The X-rays have undoubtedly a powerful influence in certain cases, but they must be employed judi- with caution in children. Their effect upon tuberculous tissues n markedly successful. The ordinary surgeon has not sufficient n technic to use them with safety and an expert operator is It must always be remembered that the X-ray is a powerful that most serious results may follow its prolonged or too lication. Not only are X-ray burns exceedingly difficult to ie condensation and devitalization of tissues in children are ı cause of death. The therapeutic action of the X-ray is un- est exerted in stimulating metabolism and increasing the re- on of the local cells against the invader. This metabolism, ist not be stimulated too greatly, lest toxic products be swept culation, either overloading the kidneys or causing deleterious other regions.

THE PAEDIATRIC SURGEON.

r to properly diagnose and treat the diseases and conditions of he surgeon must possess great powers of acute personal obser- , wise judgment, discretion, sympathy, patience, firmness with ind an innate love of children that will at once inspire confi- lispel fear. He should always be an optimist, by his words, nanner inspiring hope, faith, and courage. Even very young l at once detect the one who is their friend and under ordinary es will respond quickly to tactful advances, provided these have o suddenly forced upon them. Time spent in cheery words any an outbreak of crying from fright, or rebellion from inju- ances. A frightened child will never reveal its true condition ms. While young children can furnish no words of explana- eir condition, their silence is counterbalanced by the fact that al in their actions and do not mislead either intentionally or s is sometimes the case with adults. An infant or young child examined when held in the lap of the mother. Fear must al- yed by gentleness and by the absence of haste. In older chil- et but firm manner will accomplish much, except in spoiled th a really bad child, prompt and firm measures are sometimes Ungovernable children will often puzzle the surgeon, and

render his examination so unsatisfactory that a diagnosis will be uncertain until several studies have been made.

Method and System.—The children's surgeon should persistently instil into the minds of parents the fact that method, system, regularity of feeding and sleeping are of the utmost importance in the management of children. Many a mother becomes a nervous wreck simply from lack of systematic training of her charges. That they are cross and irritable in the middle of the afternoon is due to the fact that she has not compelled all those who are under seven years of age to take a nap or a complete rest in the middle of the day. The worst examples of unkindness to children are the parents who allow them to have their own way in matters that should be wisely and judiciously decided by an adult. A diseased child, especially one that is likely to suffer from a long surgical disorder, needs most of all to be taught that obedience and self-control are essential to its happiness. This can be done gently but firmly by a wise mother, even with an infant. The most unhappy invalids are those who have been spoiled by mistaken indulgence, both parents and children being rendered physically and mentally miserable, while cure is retarded. A wise, firm control will secure the habit of obedience without any severe measures and the result will be most beneficial not only through the period of illness, but throughout life.

History.—A simple and systematic history of the disease should be recorded: on cards, if the surgeon wishes to be in fashion; in large history books, with separate general index of both names and diseases, if he desires rapidity and convenience. At the end of forty years the mass of cards will be so great that he will discover after minutes of search that his fingernail has missed the one card that he desired, and he must repeat his hunt. With a book index he can run over a hundred names in a few seconds. Cards of course have the advantage of flexibility of arrangement and ease of removal, but the latter is not always desirable.

In children, the history must usually be obtained from the parent or nurse, and the judgment of the surgeon must be exercised closely to exclude the unimportant and to seize upon the essential items. Time may be saved by a nurse undressing the child in another room, while the surgeon, by judicious questioning of the parent, elicits a concise and intelligent history as to the supposed causes of the present condition, important occurrences at birth, accidents and diseases during infancy and childhood, feeding, nursing, environments, etc. There is always great reluctance upon the part of parents to disclose any weakness or taint that would discredit the family in any way, and all histories are to be looked upon with a critical and discerning judgment. Cerebral degeneracy is so commonly a cause of spastic, choreic, tetanic and athetoid movements that the physician should carefully note all the evidences, without trusting to the statements of the mother, which are often either intentionally or unintentionally misleading. Again, an accident or a cause that has undoubtedly been productive of the condition may have seemed so trivial as to have been entirely overlooked or forgotten.

Age and Sex.—In young children differences are but slight between boys and girls, but as age increases, differences in sports, occupations, etc., will alter the causes of disease, and after puberty the physical and psychical effects of sex will be more marked.

nusual disturbances and derangements of the nervous and mus-
ems at puberty must be considered, but the emotional element
hile of great importance, should not lead the surgeon to overlook
ase.

ung children, the highly sensitive condition of the nervous sys-
be carefully taken into account. In young boys the vicious
abit will have its marked effect upon the nervous system. Ex-
sturbation may also be found even in young subjects. The
recently seen a case of sexual excitation produced by crossed
in a girl of twenty-one months. Various diagnoses of the con-
been made, even that of spinal caries.

ination.—The first approach of the surgeon to children is not to
as confidence must first be secured. Quiet, calm, and firm
manipulations are best. The unaffected side is first examined
should be avoided in every case. If pain must be inflicted, it
announced in advance and bravery encouraged. When such
be expected, an anesthetic like nitrous oxide or ethyl chloride
given; it is cruel to subject an infant to pain that would not be
n adult.

ery surgeon's office should be a plentiful variety of TOYS, pic-
dy, etc., since these adjuncts will frequently induce natural
ch could not be secured in any other way. Many a frightened,
d can be converted into a smiling patient by a few toys, and in
ssume the natural positions, the character of locomotion, and
les that will reveal to the keen practised eye of the surgeon
question all the knowledge that he requires for his diagnosis.
at will not walk at a command will readily chase a ball, or play
d one that will not walk in the opposite direction from its mother
y follow her to the far end of the room, especially if the surgeon
self behind. The eyes, ears, and hands of the surgeon must all
t into requisition more constantly than the tongue.

of the required varieties of entertainment which are most help-
en in Fig. 13. Diversion of attention is very important and a
is very seductive.

conditions, especially few deformities, can be properly inves-
less the child is ENTIRELY STRIPPED in a warm room. For this
e surgeon should keep in his office a supply of LOOSE WRAPPERS
down to the feet in the back and a skirt with elastic waist-
irls. These gowns will permit, even in large adolescents, a satis-
amination and yet preserve natural modesty. The large propor-
TAKES in diagnosis can be directly traced to FAILURE TO REMOVE
The movements and attitude of the bared body will disclose
es of form or gait (Fig. 14), and comparison of the two halves of
s a most essential requirement. No surgeon can properly detect
rences through the clothing, nor can he discover the many alter-
orm and figure that are the result of disease or deformity. The
d should be encouraged to walk, play, stoop, creep, and talk.
g upon a table all the normal movements of the spine, arms, and
l be first examined, followed by a similar gentle investigation on

the injured or diseased side. In searching for tuberculosis of joints and bones, consideration should be given to the history both of heredity and environment; to the existence of lymph-nodes, carious teeth, etc. In searching for the signs of rickets, the head-sweating, beaded ribs, craniotabes, violin-

FIG. 13.—Playthings,—essential in the office of a children's surgeon.

shaped chest, prominent abdomen, and bony distortions of legs and arms should be noted. A too small thorax will often produce improper development of the lungs and improper oxidation of the blood with faulty nutrition. All malformations of the sexual organs should be discovered and

FIG. 14*A*.—Walking child. (Muybridge process.)

FIG. 14*B*.—Running high jump.

(Keating's Diseases of Children.)

operated upon before the child mingles with his fellows. If the child is made oversensitive by ridicule, his after life is apt to be rendered morbid and degenerate. No portion of their anatomy receives so much thought with males as the sexual organs.

Facies.—The expression of the face in obstruction from adenoids and in imbecility, the anxious face of the child with laryngeal obstruction, the pinched countenance of spinal caries, the frown of tubercular meningitis, the teeth of the hereditary syphilitic are all diagnostic.

Palpation.—An educated, sensitive touch is all-important in detecting disease. The older surgeons greatly excelled the present generation in the extent to which they developed their powers of observation and of touch. Agnew seemed to have an eye at the end of each of his fingers. Too often at the present day, the exploratory knife is made to take the place of brains and of education of tactile sense. The surgeon now flies to the X-ray or the laboratory to solve the question that could have been much more accurately done by a judicious and trained surgical acumen and a reasonable amount of cerebration. The knife should be used only after the evidence of all available symptoms has been weighed. The wise surgeon will be aggressive and conservative in proportion to his breadth of knowledge. If ignorant or careless, he will prove a failure and his work a disaster.

Limping.—Limping is always a suspicious sign and should be carefully investigated while the child is nude. It should never be carelessly dismissed as a trivial symptom, or as one caused by rheumatism. This most common and unjustifiable error results in hundreds of cases of life-long, handicapping crippledom or in excision or death. It should be remembered that RHEUMATISM OF A SINGLE JOINT IN CHILDREN, WITHOUT POSITIVE INFLAMMATORY SIGNS, DOES NOT EXIST, and some other cause for the symptoms should be sought. In a large majority of cases an incipient tuberculous or inflammatory bone disease of spine, hip, knee, or other joint will be discovered as the cause of the limp, the primary symptom of which will be muscular rigidity. The limp may be caused either by this rigidity or by the sensitiveness of the deeper tissues of the joint, recognized by the child's brain, yet not sufficient to produce a discoverable pain even on motion.

Tenderness and Pain.—Tenderness can usually be located, and in a child is rarely simulated. Pain, while a most valuable symptom, is one that may be misleading, as it is an unreliable symptom. It may be severe in a condition of moderate gravity; on the other hand, it may be almost if not entirely absent in disease of the gravest import. Reflected pains are also common and are often at a decided distance from the real seat of trouble. Continued pain in the abdomen in children should always be looked upon as suspicious of vertebral or other disease. Pain in the leg or lower arm should always lead to an investigation of the parts nearer the body, and it will frequently be found that joint disease or nerve pressure is the cause.

Local and general pain require close observation for their interpretation, as a child may cry lustily at the mere touch of the surgeon. The statements of the mother and nurse become important upon this subject. Pain and difficult breathing, for instance, may indicate pleurisy, empyema,

a, croup, or a foreign body in the air-passages. The author has cheotomy performed for foreign body in the bronchus, when the really suffering from double pneumonia (p. 77).

NTARY MOTIONS are difficult to interpret in a young child. An y even use its arms vigorously with fracture of the clavicle. The amination of regions, as spine, joints, feet, chest, genitalia, etc., ted under the separate heads. The HEART AND LUNGS always ose examination, especially if gymnastics are to be ordered. erature, pulse, and respiration must be wisely compared not each other, but with the other clinical aspects of the patient. riological, microscopical, and clinical conditions should be closely ssisted by the X-ray, the blood-count, the urine examination, l doubtful cases.

lity.—The influence of heredity in the production of disease and is too well established to be successfully denied. Why sur- thoroughly believe in the influence of heredity in their pur- horses and dogs can deny that the same tendency exists in the imal is past comprehension. No surgeon would purchase the known tuberculous cow. Hereditary effect upon figure, form, and idiosyncrasy is thoroughly established. This does not a certain disease must necessarily be transmitted any more liarities of face. Heredity means simply that the cells of an tainted by constitutional disease, as cancer, tuberculosis, or re far less resistive to the inroads of the besieging germs than are of individuals of normal type. An injury or a sickness which readily resisted by a healthy child may prove disastrous in one r a hereditary or acquired taint. Health in every individual is y maintained only by the resistive powers. Health may be d in spite of injurious influence either from without or within, cell production is much more easily accomplished in one case ne other. HEREDITY THEN MEANS, NOT THE DIRECT TRANSMIS- ISEASED CELLS, BUT NON-RESISTANCE OF CELLS AGAINST A CER- CTING INFLUENCE (see p. 371). All faulty cell weaknesses and , therefore, should be noted, as neuroses, tuberculosis, syphilis, .

endency at the present time is to belittle the effect of heredity losis. While environment and exposure to adverse influences fe undoubtedly seriously increase the probabilities of infection, imary cause, a transmitted lack of cell resistance, is a large ele- viting the infection by the tubercle bacillus (see p. 373). A dis- readily pass over one generation and appear in the grandchild; we may not agree with Gross, that all tuberculosis is a descend- hilis in some previous generation, one must always bear in mind n nature of this latter infection and be alert to meet the baneful Many obscure lesions are solved by closely questioning the by a course of specific treatment. In suspected HEREDITARY the rhagades, the teeth, glands, skin, etc., should all be investi- vell as the history of the father and mother, and the number of (p. 315).

The diagnosis of CONGENITAL MALFORMATIONS of the sexual organs in girls can be facilitated by the gentle introduction of the finger into the rectum under anesthesia. The vagina in young children is too small to permit satisfactory palpation, but by the rectum the whole pelvis can be explored and the presence or absence of uterus, ovaries or tubes determined by bimanual palpation. Abnormal growths, as ovarian cysts, dermoids, tuberculous pus collections, can also be reached through the rectum.

The early demonstration of sex is often important in pseudohermaphroditism in order that an appropriate name can be given in baptism and that the child be reared in conformity with its probable sex (see Hermaphroditism, p. 189).

Radium Therapy.—Radium as a curative agent, while it has proven its undoubted beneficial action upon cancerous disease, has not yet been sufficiently applied to tuberculous and other processes to determine its advantages.[1] So little understood are its mysterious properties, that the future may hold great possibilities. If radium exists in positive quantities in rocks, sufficient to elevate the temperature of the earth in deep mountain tunnels, its influence is yet in its infancy. Tablets containing crystalline radium salts (Radiosal, emanosal) are now manufactured for preparing radio-active baths.

ANESTHESIA.

Few operations of magnitude or of long duration can be satisfactorily performed in children except under general anesthesia. It is cruel to deny insensibility to pain—analgesia—to a child unable to resist brute force, when under similar conditions the adult would demand it. In fractures a satisfactory adjustment can rarely be accomplished except under anesthesia, and no case of bone injury near a joint should ever be undiagnosed when anesthesia and the X-ray would settle the question. In opening abscesses much suffering may be spared by a local analgesic. The depressing effect of ether, however, is often less than would be the shock excited by fear at the sight of instruments and blood, consequently, local and sequestration anesthesia are seldom advisable in young children, although in adolescents they are very useful.

ETHER.

The consensus of opinion of American surgeons is decidedly in favor of the safety of ether as compared with chloroform. Statistics covering 300,000 ether administrations give a mortality of 1 in 15,000. Alice Magaw, at the Mayo Clinic, reports 15,000 personal administrations without a death.[2] The death rate from nitrous oxide is estimated at 1 in 100,000; Thomas reports 1 death in 270,000 in dentistry. The disadvantages of ether are, of course, its slower action, its unpleasant odor, the coughing, pharyngeal mucus, etc., and its liability to be followed by nausea and vomiting. It is contraindicated in bronchitis, heart and kidney disease,

[1] Abbe, Trans. Amer. Surg. Assoc., xxii, 1904, 253; Berlin. klin. Wochenschr., 1907, No. 23.

[2] Mellish and Bouffleur's statistics (Jour. Amer. Med. Assoc., Dec. 5, 1905) of 1,500,000 cases give a mortality of 1 in 3355 for chloroform and 1 in 16,768 for ether.

s lungs, and in operations on the head and neck at night or autery is to be used. Even a slight bronchitis may be converted umonia by etherization, but this danger is largely avoided if an is employed that permits the ether vapor to be warmed.

Method.—The slow, continuous drop of ether upon several layers pread upon a wire frame has the advantage of fresh gauze for t. It permits oxidation of the vapor, partially avoids rebreathing us material, does not suffocate, lessens time and quantity, is more action, and is safe and simple. Its great disadvantage is the the intaken vapor. Experimentation has proven that the vapor luces temperature more than 30 degrees, a fact that will explain e cases of postoperative bronchitis and pneumonia, as well as d shock. The Cunningham apparatus aims to correct these pecial methods. The thermo-ether inhaler[1] also partially overcomes this objection. When it is recalled that the surface of the air vesicles is far greater than that of the body surface, the chilling effect of ether can be well recognized in the production of ether pneumonia.

inhaler, which admits air freely o the ether vapor.

The Allis etherizer (Fig. 15) permits free entrance and exit of air, but the time required to change the cross bandages in the frame-work renders it impossible to give to each patient a clean inhaler such as can be secured by gauze on the wire frame.

ssential elements in safety, with any analgesic, consist in a pection of conditions, good preliminary preparation of the d especially the recognition by the anesthetist of the fact that on of insensibility to pain is always an operation attended with

ration of Patient.— Whenever time permits, the urine, blood, lungs should be carefully examined. Candy, chewing gum, and l be removed from the mouth. The bowels should be freely several days previous to the administration, to avoid intestinal n.

—Infants must, of course, be nursed or fed two hours previous ration; other children according to age should have food re- far as possible, especially when ether is to be administered. In , lavage should be practised if a recent meal has been inad- en. The nearest approach to an ether death in the experience nor was many years ago, in a most trivial operation, when he l that no food had been taken by the patient. The child became lly asphyxiated by the packing of the closed mouth, pharynx, with large masses of vomited food. Never, since that expe- anesthesia been undertaken without an assistant. Spraying

[1] Cunningham, Jour. Amer. Med. Assoc., 1908, 1574.

the nose and fauces with cocaine lessens pharyngeal mucus. The amount of anesthetic required may be lessened by a previous hypodermic of morphia and atropia or scopolamine in doses proportionate to the age ($\frac{1}{50}$ to $\frac{1}{100}$ gr. of morphia; $\frac{1}{200}$ to $\frac{1}{1000}$ of atropia; $\frac{1}{200}$ of scopolamine or $\frac{1}{200}$ to $\frac{1}{500}$ of strychnia). This hypodermic also greatly lessens the postoperative pain, the patient sleeps slowly out of ether, vomiting is less, and if the dose has been properly planned, the kidney secretion will not be lessened. Dawbarn prolongs the effect of ether by confining a portion of the blood in a leg during operations.

Anesthetist.—Every hospital should employ trained and skilled anesthetists, and not entrust this most serious cause of postoperative complications and death to inexperienced internes. The author recalls with pleasure a Resident who was honest enough, when requested to etherize a patient for a prolonged abdominal operation, to confess that he had never anesthetized a case. It is hardly necessary to state that the anesthetist for children should be more tactful and experienced than in the case of adults. He should secure the child's confidence by a few cheery words and the drug should not be applied too suddenly. A few preliminary whiffs of cologne or primary administration of nitrous oxide or ethyl chloride will do much to relieve the suffocating feeling of ether.

The preliminary approach of the drug should be cautious and gradual to avoid exciting opposition, but should blandishments fail and struggling commence, rapid completion of the process is advisable.

NITROUS OXIDE.

Nitrous oxide is an ideal anesthetic for short operations in children, owing to its safety and the speedy production of unconsciousness (one minute), the absence of odor, choking sensations, strugglings, and subsequent nausea, and the quick recovery within half a minute. It is excellent for opening abscesses, empyema, fistula, reducing dislocations, opening felons, exploratory operations, tenotomies, and in fact for nearly half of the minor operations.[1] It does not sufficiently relax muscles, however, to be of service in breaking up adhesions of joints. It is the safest anesthetic in kidney and lung complications, but not in valvular or myocardial disease.

Nitrous Oxide-Oxygen-Ether Sequence.—The admixture of oxygen with nitrous oxide and with ether requires a special regulating apparatus.[2] The oxygen diminishes the cyanosis and asphyxia. The combination of air (15 to 18 per cent.), oxygen (5 to 8 per cent.), and nitrous oxide has resulted in the safe employment of the mixture for long major operations of an hour or more, and offers excellent results, shortening the primary stage, resulting in less subsequent nausea and vomiting and less chilling of the lungs. It is expensive for long operations.

Nitrous Oxide-Ether Sequence.—Nitrous oxide is often given as the initial stage of ether anesthesia to avoid the unpleasant smell and effect of the latter, but it is difficult to bring the patient quickly enough under

[1] Wyeth's Surg., 1908, 18.
[2] Jour. Amer. Med. Assoc., Nov., 1908, 1574.

oid an intermediate stage of partial awakening and struggling, anesthetist is very expert. Less than a minute is required in produce the primary impression, thus avoiding fright and and with experience, ether unconsciousness may be secured in ve minutes. The absence of struggling against the suffocating ced by ether is very important in children.

CHLOROFORM.

form is such a delightful anesthetic and is so free from unpleasfects that it is most unfortunate that it is not safer in its action. is extensively used in Europe, and in the West and the South in our own country, the death rate is very high compared to that of ether, 5 to 1. It kills quickly and without warning, by heart paralysis as it is a heart depressant, syncope occurring with extreme dilatation of the capillaries.[1] Authorities differ in their conclusions as to whether respiratory failure precedes that of the heart.

ealed glass ning chloroit for ad-

Chloroform should never be given rapidly or in large doses. Its only safety lies in the experience and conscientiousness of the anesthetist. A mask should never be used, as the admixture of abundant air is imperative.[2] Patients should never be chloroformed in the sitting posture. The face should be smeared with ointment to prevent blistering. The slow, continuous drop upon gauze held at a distance of several inches from the face is safest. Close contact of the gauze to the face may give a ten per cent. vapor of chloroform, five times as strong as safety permits. Sealed glass ampoules are convenient (Fig. 16).

r Symptoms.—Sudden dilatation of the pupil means danger. d irregular respiration, pallor followed by duskiness, a rapid and ulse, all render imperative the suspension or diminution of the If these symptoms are continued, the drawing forward of the forward pressure on the angles of the lower jaw or by tongue version of the child, artificial respiration, the administration of ine solution, or adrenalin in the veins,[3] or intralaryngeal insufflathe Fell-O'Dwyer apparatus, Fig. 58, p. 81, one or all may cessary.

ETHYL CHLORIDE.

chloride by inhalation upon gauze is a very speedy method of sensibility for short operations.[4] Its mortality is 1 in 1000. It xcellent preliminary step to full etherization and is largely used

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rd, Jour. Amer. Med. Assoc., Nov., 1908, 1574.
d and Adler, Anesthesia and Anesthetics, Physicians' Leisure Library, Octavo is, Detroit.
Jour. Experimental Medicine, viii, Dec. 6, 1906.
members of the Anesthesia Committee of the Surgical Section of the Amer. consider it, however, one of the most dangerous.

both in hospitals and in office practice.[1] Ethyl bromide is also dangerous.

Lavage.—Thorough washing of the stomach before removal from the operating table will prevent nausea and vomiting. It should invariably be done in intestinal obstructions both before and after operation, in order to prevent fecal infection of air-passages and septic pneumonia.

Postoperative retching may be controlled by the previous preparation of the patient, and by the inhalation of vinegar, and in persistent cases, by large draughts of warm water for small children, or by lavage for adolescents. Children bear water easily in large quantities, which is of great advantage in preventing suppression of urine, frequent large draughts of water being the best diuretic. Water, either hot or cold, is preferable to cracked ice; the latter leaves the mouth hot and dry. Dry calomel on the tongue, or cocaine or sparteine, will relieve the nausea.

LOCAL ANESTHESIA.

Cold—Freezing.—The local influence of cold may be employed with advantage in many slight operations. If the skin is covered with salt and a lump of ice placed over it, benumbing speedily takes place. A spray of ETHYL CHLORIDE OR ETHER will remove from the child much of the terror of a hypodermic injection. Liquid air has also been employed. Abscesses can thus be opened without pain and much suffering avoided. Simple drainage in empyema, laying open of sinuses and boils, are but a few of the conditions in which pain can be much lessened. The glass or metal tubes of ethyl chloride (under its various names, kelene, anestile, etc.) are a most convenient form for office use. The freezing must be of short duration so that tissues are not devitalized. If the surface of a carbuncle is brushed over with pure carbolic acid, the pain of the incisions will be greatly lessened. For simple tenotomies, when forcible after-stretching is not required, general analgesia is seldom demanded.

Infiltration Anesthesia.—*Cocaine*, 2 per cent. solution, has but little influence upon the skin, but on all mucous membranes it will give great relief from pain. In the removal of foreign bodies and in all manipulations on nose, throat, eyes, rectum, and urethra it is invaluable. The benumbing of connective tissue as produced by subcutaneous injection of salt solution or of cocaine is exceedingly useful. For ordinary infiltration, a hypodermic is sufficient; for the massive infiltrations of Matas[2] a large syringe is required and 1:1000 solutions are usually employed. If the skin is first frozen with ethyl chloride, even children will complain but little. The infiltration should be made by advancing the needle slowly and watching closely the blanching of the tissues.[3]

Novocaine is said to be about one-sixth as toxic as cocaine, and can be sterilized by boiling. It is employed in $\frac{1}{8}$ to $\frac{1}{20}$ grain doses, with suprarenin hydrochloric synthetic gr. $\frac{1}{100}$. *Tropacocaine* is also sometimes employed.

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[1] Lee, Annals of Surgery, Nov., 1908, 641.

[2] Trans. Amer. Surg. Assoc., xix, 413; Phila. Med. Jour., Nov. 3, 1900; Painless Operations, 5th Edition, 1906.

[3] Wyeth's Surgery, 1908, 26.

or two per cent. solution of *eucaine* can be sterilized by boiling, roduce as much vasomotor constriction and is one-fourth as caine. Tablets containing 0.05 Gm. cocaine and 0.00016 gr. Mitchell) can be sterilized by dry heat. One tablet in 5 c.c. of n gives a one per cent. solution which may be further diluted. lute the solution, the larger can be the amount of fluid injected. of one part of alypin and one of cocaine to 10,000 of sterile d permit an injection of several litres.[1]

h now advocates as reliable and non-poisonous, the following ons:

1		2		3	
.....	0.1	Cocaine.....	0.05	Cocaine.....	0.01
.....	0.1	Alypin.....	0.05	Alypin.....	0.01
oride...	0.2	Sod. chloride.....	0.2	Sod. chloride...	0.2
il.....	100.0	Aq. destil.....	100.00	Aq. destil.....	100.00

nfiltration anesthesia requires considerable time for its proper t is being employed more and more extensively. Nausea, hock, and subsequent kidney and lung complications are greatly Many operations can be performed and patients sent directly mes, thus greatly relieving hospitals. In hernial operations or fever perforations in children, it is especially useful. Circum- ping of hydrocele and opening of abscesses, and periosteal and ncisions are operations especially suited to infiltration anesthesia. augments and prolongs the effect.

tration Anesthesia.[1]—Local freedom from pain may also be greatly n limbs by applying RUBBER BANDAGES above and below the rea before introducing the hypodermic. From 50 to 80 c.c. of a per cent. solution of novocaine or of cocaine may be injected nnective tissue.[2] The fingers, toes, penis, and limbs are especially for this form of application of infiltration. Neural infiltration dvisable, but nerve blocking through an open incision may lessen inal and rectal[3] anesthesia are seldom employed in children. injections of STOVAINE, with or without strychnia, incur the ury to the cord and are not as safe as ether, although Gray his method largely in children.

d Chloroform Poisoning.—Bevan[4] has called attention to late r operations due to the development of a rapid fatty degenera- liver, producing a toxemia. This altered metabolism of a yet haracter sometimes results in very unexpected deaths, following r operations. The fatal issue in children may closely follow but is usually delayed for several days. It is more frequent nat have been repeatedly subjected to chloroform anesthesia. is diminished, creatin increased, and acetonuria present with

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's Surgery, Nov., 1908, 26.
s of Surgery, Nov., 1908, 780.
ngham, Boston Med. and Surg. Jour., 1898; Legget, Ann. of Surg., 1907, 590; Med. Assoc., Nov., 1908, 1574; Vander Veer, Jour. Med. Soc. N. J., 1907.
, Jour. Amer. Med. Assoc., 1905, Sept. 2, 694; Howland and Richards, Ann. r., 1909, 419.

sweetish breath. The author lost a case on the fourth day after a slight and entirely aseptic operation. The case had undergone a number of previous chloroformizations. Kidney disease was excluded. The symptoms were restlessness, delirium, sudden shrieks as of pain, somnolence and death, with slight tinging of skin. Autopsy was refused.

OPERATIVE MEASURES.

Asepsis and Antisepsis.—Asepsis is so absolutely essential in preventing infection of wounds that its importance cannot be overestimated. In children the production of asepsis by the use of antiseptics is permissible, but the sensitiveness of their skins must be considered and solutions weakened. Soap and hot water are the best of all agents for removing dirt and epithelium. Brush scrubbing should never show blood; gauze sponging is better. Several days of preparation are needed for thickened epithelium of feet. Ointments or poultices are helpful in softening calloused epiderm. Corns and callosities must be pared away, as they become very painful under plaster dressings. Corrosive sublimate is better borne by the skin than carbolic acid. For emergencies, painting the skin with iodine is most effective.

Iodoform.—The author never uses iodoform except in a very few tuberculous cases. Its vile odor should debar it from use. Its only value is in the iodine that it contains and pleasanter preparations equally rich in iodine, as thymol diiodide (aristol), etc., are just as efficient and only slightly more expensive, as a much less quantity is required. Iothion, a liquid rich in iodine, may be used in sinuses.

Preparation for Operation.—Fear is such an important element in shock that it is well to avoid it by withholding knowledge of the anticipated operation from the child on the previous day. When the time arrives, however, for preparation by antiseptics, the physician or nurse should, if the child has attained the age of reason, calmly and quietly state to the little one what steps are proposed to be taken; to promise relief of pain by an analgesic and assure his mind of the absence of danger and as to the benefit to be expected. Preparations for an operation should always be conducted away from the sight and hearing of the patient, and instruments should be kept out of sight until needed. The exception to this will be when a strong mental impression is intended to be made upon a masturbating boy requiring circumcision, and where the future restraining influence is desirable. When possible, the child should be admitted to a hospital several days in advance of an operation, in order that he may become thoroughly acquainted with the nurses and with his surroundings. No operation except emergencies should be performed unless the child is in good physical condition. In plastic surgery this rule is absolute. If parents are within hearing of the operating table, they should be warned that the cries of the child will be from annoyance, not from pain. Parents are especially dangerous as assistants, since in an emergency they are helpless.

Blood-count.—In deciding upon any operation, in acute surgical conditions in children, the entire group of clinical symptoms must be considered, the blood-count being but one element in arriving at conclusions, and

t the relative proportion of the polynuclear neutrophiles to
mber of leucocytes is of more importance than the actual
ucocytes. The number of normal leucocytes at birth is from
,000 in children; the average may be placed at 6000 to 12,000
llimetre, but even digestion may rapidly raise the number, as
ercise or bathing. A leucopenia or decrease in the total
irculating leucocytes may be present even with an increase
e leucocytes or eosinophiles or neutrophilic leucocytes. Lym-
s not only found in infants but also in young children,
the poorly nourished rachitics or in victims of congenital
he normal percentage of leucocytes (Kelley) may be stated
ly as:

	Infants.	Adults.
hocytes	40–60	20–30
mononuclears	4–12	4–8
norphonuclears	20–40	62–72
ophiles	2–4	1–4

lren the proportion of lymphocytes progressively decreases
irst ten years, while the polynuclear leucocytes increase.
–Shock can be avoided by economizing animal heat by wrap-
tions of the body outside the operative area in cotton covered
paper; by the use of electrically heated or hot water operating
water bottles upon the table, by quickly arresting all hemor-
y care and non-exposure of surface *before*, *during*, and *after* the
Watery antiseptic solutions should be used sparingly, since if
is allowed to lie in a cold pool through the operation, great loss
be unavoidable. When there has been large loss of blood,
lysis is helpful, or venous injection of salt solution, or con-
) by drop proctoclysis (p. 126). An ounce of salt solution in the
adily absorbed during an operation and it is usually advisable
couple of ounces before the patient leaves the table.
ons of two to ten minims of a 2 per cent. solution of eucaine
ng the nerve-trunk will lessen traumatic shock. Blood-pressure
served by a sphygmomanometer and may be raised by hypo-
ctions of camphor, strychnine, digitalis, caffeine or adrenalin.
ould be lowered and the limbs firmly bandaged over the cotton
e blood in the trunk.
rative Treatment.—PAIN.—The cause of pain following an ope-
ld always be earnestly sought both by surgeon and nurse.
a slight change of position will give relief. A small pad under
e elevation of a member, the loosening of a tight bandage, the
the gap in a plaster cast (which gap should always be made
ast is but semi-hardened), or the shifting of a splint are often
measures. Many children are too young to indicate the site of
d suffer greatly if the surgeon is careless. For the relief of
oric and bromides are best for young children. In adolescents,
ay be given in doses appropriate to the age.
ain in the back so frequently present after operation may be
placing a pad under the lumbar region while the patient is

undergoing the operation, thus preventing the lumbosacral strain, and by a pad in the same position during subsequent dorsal recumbency, or by turning the patient frequently. After appendicitis with peritonitis the child is best placed upright in a rocking-chair or held in the arms of a nurse.

Children can be placed in ROLLING CHAIRS very early and with great relief to body and mind. A constrained or fixed position is very wearisome to a child and will prevent sleep. Unless positively contraindicated, it is best to allow the child to assume any comfortable position. If a part is fixed in plaster, it can be freely moved by the nurse without injury.

CATHETERIZATION is rarely if ever required in children, especially if they are lifted upon a commode or chamber.

Children bear water and milk early and with benefit, often within an hour; two to four drachm doses can be given repeatedly. Cool water is far better than cracked ice. The latter in a few minutes leaves the mouth hot and dry, and the tissues need water.

As a rule, the bowels will move naturally in a few days. If sluggish, peristalsis may be stimulated by suppository or enema, or in an infant by simply making intermittent pressure upon the anus. In operations for appendicitis or intussusception, purgatives are injurious.

After fractures, dislocations, or operations on joints, delay in employing massage, voluntary and involuntary movements, and gymnastic exercises often results in stiffening or ankylosis.

After operations for club-foot, knock-knee, bowed legs, etc., long and patient oversight is required, together with the support of appropriate apparatus.

After an excision of a tuberculous joint, the patient should be placed in a very few days upon an open porch and every attention given to hygienic surroundings (p. 380).

Dressings.—The frequent dressing of wounds in children is always to be avoided, as it has a serious and depressing effect. One of the great advantages of antiseptic dressings and catgut sutures is the length of time between such disturbances of the child. The gain of plaster of Paris over other forms of fixation splints is the fact that the parts are kept so absolutely free from motion that pain is practically abolished and dressings are rendered very infrequent. Also, all dressings should be conducted in a separate room and as far as possible from the hearing and sight of other patients (p. 232), and NEVER IN THE WARD in the presence of other children. It is cruel and injurious to inflict unnecessary psychical pain.

An efficient, calm, and gentle nurse is all-important, and as a rule is a much better caretaker than the parent.

Surgical Scarlet Fever.—The susceptibility of operated and wounded children to scarlet fever has often been noted, even when no evidence of sepsis is present. Whether the eruption is accidental from specific infection or an erythema, the existence of high fever and a scarlet rash certainly gives credence to the belief that it is a true scarlatina, since it is communicable to other patients and is followed by albuminuria and desquamation. If the child has been recently exposed to scarlet fever, diphtheria, or other exanthematous disease, no operation should be performed, except in emergency, until the full period of incubation has been passed.

Pains.—A very dangerous diagnosis of pains in the limbs in adolescents is that of "growing pains." Normal growth does pain, and when a child is afflicted with pain at night after an or after strains or exposure, he should be carefully examined ous joint disease, or for periostitis, or rickety hyperemia of osteomyelitis.

CHAPTER II.

SURGERY OF THE HEAD AND FACE.

HYDROCEPHALUS.

HYDROCEPHALUS is an accumulation of the cerebrospinal fluid in the ventricles of the brain or in the subarachnoid space. Acute external hydrocephalus is due to a thrombus formation in the venous sinuses, or to inflammatory conditions in the ventricles,[1] or to tuberculous infection. ACUTE INTERNAL HYDROCEPHALUS is caused by an ependymitis, with serous effusion into the ventricles and consequent distention and pressure. The symptoms will be headache, retraction of neck, convulsions, slow pulse, but only moderate elevation of temperature. CHRONIC INTERNAL HYDROCEPHALUS may be due to an occlusion of the aqueduct of Sylvius, or to any obstruction to the return of venous blood from the ventricular vessels.

FIG. 17.—Hydrocephalic child with moderately large effusion. Note oscillation of eyeballs.

The condition is often congenital and progressive, sometimes attaining enormous proportions. The fontanelles are large and permanent, the sutures open and the cranial bones thin. As the effusion increases the great disparity in the cranial vault to the size of the face becomes very apparent, the head appearing like an inverted pyramid (Fig. 17). The fronto-occipital circumference may reach thirty or more inches. The intellect is enfeebled, dentition, speech, and locomotion are retarded. Later, irritability, convulsions, coma and death take place. It is rare for the patient to live to adult life. The entire cerebrum is sometimes absent, anencephalus (Fig. 18).

ACQUIRED CHRONIC HYDROCEPHALUS usually occurs in the course of brain tumors and its diagnosis is dependent on the symptoms of such growths.

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[1] Spiller and Allen, Jour. Amer. Med. Assoc., Apr. 13, 1907; Univ. of Penna. Med. Bull., Apr., 1907.

Treatment.—If malnutrition, rickets, congenital syphilis, or alcoholism are present, appropriate special treatment may arrest the enlargement and favor ossification. Every case should receive mixed mercurial treatment. If the enlargement is of acute or inflammatory origin it should be treated with antimeningococcic serum.

Tapping.—In progressive cases, with diminishing mental powers and loss of vision, withdrawal of the fluid is justifiable; also in acute and in tuberculous meningitis and in syphilitic cases. The author has not, however, succeeded in gaining more than slight temporary benefit. A small trocar or an aspirator may be employed. The puncture may be made through the anterior or the posterior fontanelles, if open, care being taken to avoid the longitudinal sinus. Langenbeck advised puncture through the roof of the orbit to reach the anterior horn of the ventricle: the upper eyelid is raised and the puncture made at the retrotarsal fold, through the thin orbital vault. The replaced lid prevents access of air and sepsis. The puncture may also be made at any desired point by first trephining the skull, a method which permits the discovery and avoidance of blood-vessels in the dura. The regions to be avoided are the meningeal and middle cerebral arteries, the fissures of Rolando and of Sylvius and the motor and sense centres.

Fig. 18.—Acrania. A fetus born with brain absent.

Keen advises the selection of a point one and one-half or two inches above and behind the external auditory meatus to avoid the lateral sinus. After trephining, the trocar is pushed two to two and one-half inches inward and upward in the direction of a point two and one-half inches inward above the opposite external auditory meatus. The instrument by this route is carried away from the basal ganglia. The fluid should be evacuated slowly and checked if the pulse falters and convulsive movements or contractions of the pupils appear. If sudden alarming symptoms occur, a small amount of sterile saline solution may be injected. These tappings will require frequent repetitions. Spinal puncture (Fig. 19) in the cervical or lumbar regions will also temporarily relieve pressure but will need to be repeated.[1]

Ligation.—The tying of the common carotid on one side has been tried, followed in two weeks by ligation of the other in the hope of diminishing the formation of the cerebrospinal fluid from the choroid plexus. Its benefit is very problematical.

Injection.—Injections of iodine, formaldehyde or alcohol in weak solutions have been suggested to lessen reproduction of the fluid but may induce convulsions.

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[1] Keen, Trans. 10th Internat. Med. Congress.

TREPHINING AND DRAINAGE.—Continuous drainage into the tissues of the scalp or neck by small metal or rubber tubes or catgut has been advocated, but adds to the danger of infective meningitis.

The ventricles have also been drained into the *subarachnoid space*, enabling the large veins of the meninges to aid the veins of Galen and the Pacchionian bodies in carrying off the fluid.[1] Perkins has with success trephined the occipital bone and tapped the subarachnoid space beneath the cerebellum.

Drainage of the spinal canal into the *postperitoneal connective tissue* may be accomplished by laminectomy and celiotomy, or the body of a vertebra may be trephined through the abdomen and a double silver tube inserted.

In purulent meningitis the spinal canal may be flushed from the ventricle to the loins with salt solution.

BASILAR DECOMPRESSION has been practised without permanent benefit.

Hydrocephalus should not be operated if spina bifida exists, nor should the latter be attacked when the former is present, since cranial enlargement often follows even when not previously noticeable.

FIG. 19.—Third step in technic of lumbar puncture. Removal of the cerebrospinal fluid for hydrocephalus. (Pfaundler and Schlossman.)

ENCEPHALOCELE.

Synonyms: Hydrencephalocele; hernia of the meninges; meningocele; meningo-encephalocele.

This congenital defect consists of a small or large opening in the skull, permitting a hernia of the meninges containing cerebrospinal fluid with or without brain substance. The protrusion usually occurs in the occipital region (Fig. 20), but may appear in front (anterior meningocele) or downward toward the fauces, or at any point over the ventricles but not over the fontanelles. Early trauma of the embryo is the possible cause, as the coexistence of spina bifida or cleft palate would indicate a general lack of developmental supervision by the nerve centres.[2]

[1] Horsley, Jour. Amer. Med. Assoc., July 7, 1906.
[2] Haggard, Trans. Southern Surg. and Gyn. Assoc., 1904.

al cephaloceles often contain cerebellar tissue and may com-
ith lateral or with fourth ventricles. The brain is sometimes
ic and porencephalus or hydrocephalus may coexist. The
be sessile or pedunculated. It pulsates during crying or strain-
ing, and the infant complains when pres-
sure is made upon the tumor, convulsions
or coma even being excited.

ephalocele. (Agnew.)

Diagnosis.—HEMATOMA OF THE SCALP from injury during labor and DERMOID CYSTS do not lessen under pressure, and compression gives no discomfort to the child. Around the margin of a hematoma, however, a ledge may give the false impression of an opening in the skull.

Prognosis. — Fortunately these cases are likely to die early. Operative results give about 20 per cent. of fatality with later deaths from hydrocephalus or convulsions.

ent.—If the tumor is stationary, protection with a nightcap and her compress only is needed. LIGATION, single or double, and riction are dangerous, as it is impossible to determine the nature nts and sepsis is likely to follow. ASEPTIC TAPPING, either local s only a temporary measure. Injection of IODINE is dangerous. t enlarging tumors, EXCISION is justifiable under the strictest in flaps are turned back, and a clamp or a ligature placed around he dural sac, to be tightened as soon as the dura is opened and are ascertained to be only fluid. Close suturing of the sac with hould be practised, the skin flaps tightly sewn and firm aseptic pplied. If the cranial opening is small, an OSTEOPLASTIC FLAP n the outer plate of the skull may be transplanted or A CELLU- pplied. Leakage with fatal result is common, yet as excision peration that promises hope of cure, it should be undertaken surgeon, especially in pedunculated cases.

MICROCEPHALUS.

time it was argued that the mental deficiencies of idiots and d children with diminutive heads were due to the premature e fontanelles and sutures of the skull and the consequent ina- brain to enlarge normally. It is now, however, well under- e cranium is small because the brain is small and undeveloped.

ent.—LINEAR CRANIOTOMY, as performed to permit expansion has proven very dangerous to life and exceedingly disappoint- ults as regards improvement of mentality.

he strictest aseptic precautions, a furrow is cut into the skull r-line of the forehead to the occiput, an inch and a half from suture in order to escape the longitudinal sinus. This furrow ith strong rongeur forceps, the lower blade flat, as employed in (Fig. 162, p. 243), or the section may be made with a Cryer pro-

tected cranial saw, or a circular saw or drill driven by a surgical engine, or by a Gigli-Hærtel wire saw. The removal of the cerebrospinal fluid temporarily relieves pressure and an apparent gain may be noted, which is but transient.

CEPHALHEMATOMA.

Blood tumors of the scalp and beneath the pericranium frequently occur after instrumental deliveries and can be distinguished from the caput succedaneum of child-birth by the speedy subsidence of the latter condition. When the tumor is soft and the inflammatory border presents a ledge, a fracture of the skull may be simulated. The peculiar crackling sensation felt under pressure at a later period is not due to an absorption of the bone but to new bony deposits beneath the pericranium. The diagnosis from encephalocele and meningocele also is sometimes difficult, owing to the hardened rim at the base of the tumor giving the sensation of an opening in the skull, but the orifice in meningocele is rarely as large as the base of a hematoma.

Treatment.—Ice may be applied but these blood tumors, unless they suppurate, should be let alone, as absorption will slowly occur. Pressure is unnecessary. The surface may be frequently bathed with hamamelis and alcohol.

CEREBRAL HEMORRHAGE IN THE NEW-BORN.

From too long retention in the pelvis or from too violent pressure of the forceps, an intracranial hemorrhage may destroy the infant or it may be born with paralysis (see Cerebral Spastic Paralysis) or convulsions. Trephining and removal of the clot if it can be located is sometimes helpful.

DERMOID CYST.

Dermoid cysts, originating from aberrant germinal cutaneous cells of the epiblast, are found chiefly on the face and neck and head. They may exist wherever embryonal fissures have failed to close. Their contents are proliferated epidermal cells, sebaceous matter and sometimes hair and fluid, differing from ordinary sebaceous tumors of the scalp or face. They are more firm than nevi and are not discolored.

Removal is sometimes difficult, and over the cranium the operation should be conducted with caution, lest an error in diagnosis should have been made, since the bone may have been absorbed.

At the base of the nose, it is essential before attempting their removal to distinguish them from anterior meningocele. The contents cannot be pressed back into the skull and pressure does not cause the child to cry.

PORENCEPHALUS.

Porencephalus may be congenital or acquired. In the latter case, the existing cavity in the brain, usually on the cortex, is due to the late results of meningeal hemorrhage. The author trephined a child of seven, with bilateral cerebral spastic hemiplegia present since birth, with athe-

toid movements, epileptic convulsions, and weakening of mental faculties. The patient died of surgical scarlet fever on the nineteenth day. The porencephalic cavity involved the Rolandic region, was filled with several ounces of clear liquid, and the bottom of the crater opened into the lateral ventricle (Fig. 21). The cavity extended over the whole region of cortex corresponding to the distribution of the middle cerebral artery.[1]

FIG. 21.—Porencephalic brain. Cavity leading to ventricle and filled with serum.

TUBERCULOUS MENINGITIS.

Tuberculous meningitis is a condition in nearly all instances secondary to a tuberculous lesion in joint, bone, or other tissue.

Often unexpectedly and without any known cause, symptoms will present themselves due to infection from tubercle bacilli or their ptomaines through the blood current. The resultant intraventricular and meningeal effusions that follow the deposit of tubercles produce an ACUTE HYDROCEPHALUS (p. 27).

Symptoms. — The typical symptoms are restlessness, peevishness, vomiting, constipation, headache. The child loses appetite and flesh, often vomits persistently. The pain in the head causes frequent complaint either by voice or by movement of hand. At night the pain arouses the patient from sleep with a sharp meningitic scream. The child is first apathetic, then drowsy, then delirious, with convulsions and deepening coma ending in death. The child dreads the light, the pupils may be contracted or unequal, the retina congested and strabismus is common. The head is retracted and the expression anxious. Pulse and temperature are at first subnormal but rise as the disease advances toward death. The percentage index of the polynuclears to the lymphocytes is regarded as a guide in diagnosis, the tuberculous infection being indicated by an excess of lymphocytes.[2]

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[1] Willard and Lloyd, Amer. Jour. Med. Sci., Apr., 1892; Trans. Phil. Co. Med. Soc., 1891.
[2] Archives of Pediatrics, Oct., 1908.

Prognosis.—The result is always unfavorable.

Treatment.—Up to the present time treatment has utterly failed to arrest the disease. Ice bags to the head, calomel purgation, and continuous small doses of calomel are the only measures that offer any hope of temporary relief. Early blistering annoys; later it is useless.

LUMBAR PUNCTURE (Fig. 19, p. 29) with hypodermic needle through the space between the fourth and fifth lumbar spines may draw away a portion of the cerebrospinal fluid and give slight relief from pressure, but will not affect the meningeal tubercles. With the patient sitting and body bent well forward this interspace is on a line with the top of the crests of the ilia. For purposes of diagnosis, except for epidemic cerebrospinal meningitis, the bacteriological examination of the fluid has not thrown any light. The author has trephined without benefit.

Bromides, iodides, and opium are useful only as sedatives. All noise and light should be excluded from the room, the ears being stopped with cotton and the eyes covered.

ANTIMENINGOCOCCIC SERUM may be tried.

HARELIP.

Faulty development or non-union of the maxillary processes of the first visceral arch in the fetus will result in harelip, cleft palate, or other malformations. The visceral arches are developed during the third week of intra-uterine life, and by the sixth week the maxillary processes have united not only with each other but also with the lateral arches and the frontonasal process that has pushed downward from the ventral surface of the anterior part of the head to form the vomer. The oral cavity is separated from the nasal cavity by the union of the two maxillary processes of the horizontal palatal plates.[1]

FIG. 22.—Harelip on left side, with flattening of left nasal ala and cleft palate. Both defects later closed by operation.

If the maxillary and frontal processes fail to unite on either side, single harelip will result; if on both sides, double harelip. The intermaxillary, the region of the incisors, is developed from the frontonasal process, consequently harelip is never median. While it resembles the cleft lip of the hare, it practically never exists at the median line, and more frequently is found on the left than on the right side.

Varieties.—A SINGLE harelip is shown in Fig. 22. DOUBLE and COMPLICATED defects may be associated with cleft into one or both nostrils, or may notch the alveolus, or extend back through hard and soft tissues constituting CLEFT PALATE; or again the intermaxillary bone may project forward in various shapes through the divided lip and be attached to the nose (Fig. 23).

[1] Piersol's Anatomy, 60 and 1589.

Causes.—HEREDITY undoubtedly plays an important part as the malformation can often be traced through several generations of germ defect. MATERNAL IMPRESSIONS can have no affect except that a violent nervous shock in the earliest weeks of pregnancy might disturb central nerve control of embryonal cell formation. Early intra-uterine TRAUMA may also produce defective development.

Time for Operation.—As the deformity is a most unsightly one and distressing to the mother, it should receive early attention. Associated cleft palate seriously interferes with sucking by the infant and is the chief cause of the malnutrition and death in this class of cases.

Opinions differ greatly as to the time of operation. In simple or double harelip without cleft of hard palate, the operation should be delayed until the child has begun to be well nourished. The TIME OF ELECTION is during the third month, before dentition has commenced and before the infant has been exposed to exhaustive febrile diseases. It is important that the patient shall be in the best possible health, as speedy firm union is essential. Young children bear the loss of blood badly and precautions must be taken to lessen both hemorrhage and loss of bodily heat. In cases complicated with CLEFT PALATE, the time of operation varies with different surgeons. Brophy operates during the first three months, first on the cleft palate in order that more room and light be afforded for the serious internal operation, and closes the lip later; other surgeons operate first upon the lip in order to gain additional lateral pressure in narrowing the bony cleft in the palate.

FIG. 23.—Double harelip complicated with attachment of intermaxillary portion to the tip of the nose and with wide cleft of the palate.

Anesthetic.—Ethyl chloride or ether or chloroform may be administered, preferably the latter. A Junkers' anesthesia apparatus introduces the vapor within the nose without interference with the operator. Allen's apparatus is also of advantage. An extemporized apparatus is described on page 9.

Operation.—The parts should be thoroughly cleansed previous to the operation and the surgeon should use every aseptic precaution, since speedy union is essential. The nose, mouth, and throat are sprayed with boric acid solution, or bromide of potash, or cocaine solution. The child's body is swathed in cotton wadding and bandages to prevent loss of bodily heat. An assistant should stand ready to compress with fingers the coronary arteries before they are divided while his fingers can at the same time compress the facial arteries as they pass over the lower jaw. A sea sponge with string attached is packed in the mouth to prevent blood from entering the pharynx. A sharp, slender, straight bistoury, two hemostats, small toothed tissue forceps, straight needles, ligatures, sutures, and blunt scissors will be required. The incision must be planned with an artistico-surgical design in view. It is not enough to simply make two raw surfaces and bring them together, with the result of disfiguring the patient for life with a deep

depression in the border of the lip and a sunken perpendicular cicatrix. The normal lip has a central projection at the free border; to secure this, all tissue and skin must be saved, at least until the completion of the operation. The paring should therefore be made not only double V-shaped (◊) from above downward but also V-shaped from behind forward, so that the

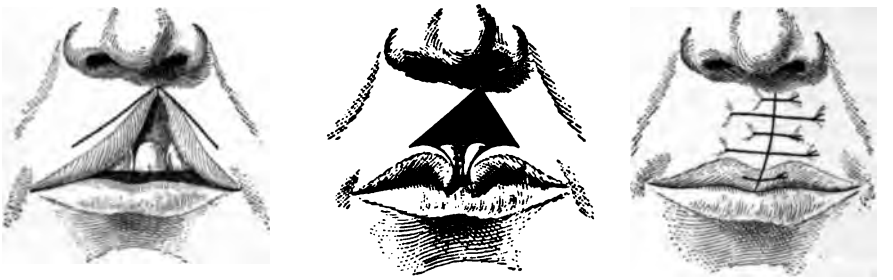

FIG. 24.—Flap operation for single harelip in order to secure final median projection of lip.

mucous surface will be shorter than the skin. It should be V-shaped perpendicularly so that when the double V (◊) angles are drawn together, the free border may be protruded.

For the simplest defect, the incisions of Nélaton are sufficient, the rhomboid space when united by sutures giving excellent closure. For deeper clefts, two parings are made from the nose down to the vermilion line, leaving the bases of the flaps attached near the border (Fig. 24). These two flaps are then drawn downward with forceps and sutured

FIG. 25.—Single harelip on right side. Fissure closed by flap operation.

FIG. 26.—Harelip closed by flap operation (Fig. 25). Central lip projection secured.

in addition to the sutures in the lip above. No tissue is sacrificed until the completion of the operation, and even then an excess should be left for future contraction (Figs. 25 and 26). Later, any surplus may be snipped with scissors. This gives ultimately a normal central eminence instead of a depression at the free lip border. Another method is to sacrifice the flap upon one side and to draw across the border a full flap from the opposite side.

ous other complicated mortising incisions have been planned
l to special deformities.[1]

num and all bands between the lip and gums are divided close
so freely that no tension remains upon the flaps.

.—Harelip pins are now rarely used, as they produce large
hey are very useful as splints to the lip in wide gaps. Silver
ad plates have also become obsolete. Black iron-dyed silk
carbolated petrolatum or colored silkworm gut or celluloid
orsehair may be used for sutures, the first stitch transfixing the
teries, the straight needle passing TO, but not THROUGH, the
mbrane. Edges must be approximated accurately, but sutures
so tightly drawn as to strangulate tissues. The mucous under
e flaps should also be sutured.

gs.—The wound may be left exposed to the air, being brushed
with a ten-grain solution of bisulphate of quinine to prevent
om licking it with the tongue, or it may be covered with com-
ure of benzoin, or with strips of gauze and collodion. Where
n exists, as when the intermaxillary section has been removed,
tic adhesive strips extending across the face from below the ears
the act of crying from making traction upon the sutures by
uscles. The flaps must be first well drawn toward the median
he application.

If harelip pins are used, the first one transfixes the coronary
others reach to, but not through, the mucous membrane. The
utures thrown over the pins in an oval or figure-of-eight manner
the edges in accurate apposition, but should NOT STRANGULATE
he tissues. The vermilion border and mucous surface are then
fine iron-dyed silk coated with carbolated petrolatum.

reatment.—The child should be fed with a spoon or eye dropper
nodynes. The mouth may be sprayed with boric acid solution
provoke crying. Sutures should be cautiously removed on the
rth day, the head being grasped and the cheeks and lips being
ted by an assistant during the procedure and afterwards fixed
ional week by long adhesive strips. During such removal, the
be tightly rolled in a towel firmly controlling the arms.

Harelip.—The operation for double harelip, if uncomplicated
ate or by protrusion of the intermaxillary bones, is conducted
ame lines as in single cleft, the parings being made to spare
ssues for flaps to cover the entire raw border of three sides of
portion or by utilizing portions of the central section and making
operations (Fig. 27).

cated Harelip.—The disposal of an intermaxillary projection
ny difficult problems (Figs. 28 and 29). If double, with cleft of
l palate, the section bearing the incisor teeth can sometimes be
into the fissure and sutured to the freshened sides of the alveolus.
premaxillary bone may be fractured and pushed backward, or
covering of the vomer may be split and dissected back with

[1] Bryant's Operative Surgery, i, 536.

the periosteum, after which with sharp osteotome or strong scissors an inverted V may be cut from the bone. In some cases, however, this procedure interferes with the subsequent closure of the bony cleft.

If the cleft palate operation is done primarily, the bony portion of this intermaxillary projection may be utilized, or it may be cut away with chisel or bone forceps or knife, care being taken to preserve a good septum, and soft tissues saved if available. When the central portion is attached far

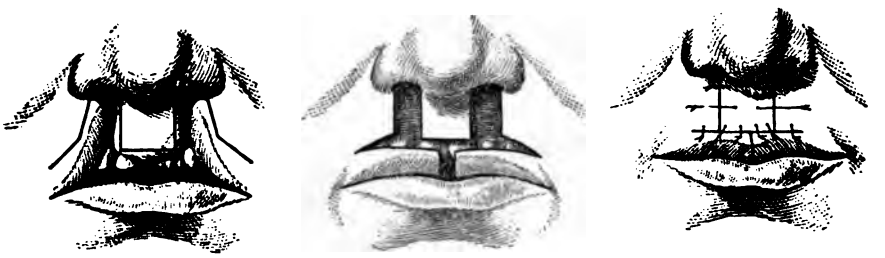

FIG. 27.—Flap operation in double harelip, when intermaxillary portion can be utilized.

forward on the nose, it cannot be utilized without narrowing the nostrils so much as to obstruct breathing. Care must be taken not to obstruct the nares, especially in wide clefts.

When the alveolus is fissured and one nostril depressed, the septum can sometimes be chiseled and slid aside and a plastic performed later, but when the cleft extends into the nasal cavity on one or both sides, either with or without cleft palate, a perfect result is difficult. The bony and integumentary parts of any existing intermaxillary portion should be uti-

FIG. 28.—Complicated double harelip with cleft of hard and soft palate. Intermaxillary segment attached to nose. For result see Fig. 29.

FIG. 29. — Result of plastic operations on child shown in Fig. 28.

lized as far as possible. A floor to the nose may be constructed by Giraldes' method by cutting flaps from the upper region of the lip, their cut surfaces to be turned upward and sutured across the nasal gap, while the tissues nearer the border are to be utilized to form plastic flaps below.

In double harelip with projecting intermaxillary portion and cleft of the nares, a paring from either side of the teat may be turned across the entrance of the floor of the nose, while the lower borders are used as plastic flaps as in Giraldes' method.

CLEFT PALATE.

Cleft palate is due to the non-union in fetal life of the frontonasal, palatal, superior maxillary, and intermaxillary processes of the first visceral arches. In normal fetal development the palatal processes of the maxillary unite in the middle line and blend with the incisive bones, while the vomer pushes downward from the frontonasal process to meet this junction. The cleft may extend in severe cases from the soft palate through the hard palate, alveolus, and lip, or it may include only a portion of this distance. The accompanying HARELIP may be SINGLE, DOUBLE, or COMPLICATED (p. 33).

Causes.—A predisposing cause is HEREDITY, this defect being noted through several generations. INTRA-UTERINE TRAUMA during the very early weeks of pregnancy may act upon the central nervous system, interfering with the controlling formative power.

ILLNESS of the mother with resultant poor nutrition of the fetus may also assist in producing the deformity. The arches having failed to unite in the early intra-uterine months, the mechanical pressure of the lower jaw and the wedge action of the tongue force wider the yielding cleft.

FIG. 30.—Cleft palate of mildest degree and easily closed.

Time of Operation.—The time for operation will depend upon the procedure decided upon. Formerly surgeons advised waiting until the third year, *i.e.*, beyond the period of primary dentition, the palatal plastic operation being preceded by closure of the harelip in the third month of life in order to narrow the cleft by buccal pressure (Fig. 30). The disadvantage of this delay is obvious, as the muscles of phonation will not be normally developed while the child is learning to talk. Three years should certainly be the limit of waiting.

If on the other hand the Brophy method is selected, the operation should be done in the first three months of life before dentition troubles have commenced, provided the infant is thriving well, since the maxillary bones are at this period soft, cartilaginous and easily molded or fractured. Other surgeons operate when the child is only four days old. The tendency of all surgeons is to close the cleft much earlier than was formerly the custom.

If delay is necessary from any cause, forcible, manual, lateral compression[1] should be made several times in the day.

Unfortunately, in the cases of extreme deformity with wide cleft and with complicated double harelip (Fig. 31), the impossibility of sucking and the consequent malnutrition seriously interfere with operation, since it is important that healthy action be present to insure prompt primary union. Many infants die from causes resulting from faulty respiration, deglutition,

[1] Roberts, Amer. Jour. Med. Sci., July, 1907; Willard, Phila. Med. Times, 1893.

and nutrition. Early operation, therefore, is preferable if the child is moderately healthy. A special nipple to take the place of the missing palate is advisable.

If early closure of the cleft is decided upon in advance of the operation on the harelip, the correction of the disfiguring lip deformity must be deferred in spite of the objections of the parents. Room is needed for placing bone and velum sutures. Abundant electric headlight is required. A special mouth-gag and speculum are helpful, or Whitehead's gag, or two blunt cheek retractors connected behind the neck with an elastic may be employed.

The operator may stand above the patient if the head is thrown far back, Rose's head down position, over the end of the table, or he may stand at the right hand side with a bright electric light or skylight above, the infant's shoulders being supported on a sand-bag. The body and limbs should be swathed in cotton and the patient placed upon an electrically heated pad to prevent loss of body heat from shock or hemorrhage.

FIG. 31.—Cleft palate with double harelip and attachment of intermaxillary portion to the tip of the nose.

Anesthetic. — For closure of the soft palate alone, cocainization is sufficient. Even when a hard palate is to be operated upon in an adolescent, the primary paring may be made under cocaine and swallowing of blood avoided.

Chloroform is the best anesthetic. Junker's inhaler permits the vapor to be carried into the nose without interfering with the operator. Allen's apparatus is also serviceable but more expensive. An improvised inhaler may be made by covering the top of a glass or metal irrigator or funnel with gauze upon which the chloroform is dropped. A short rubber tube leads the vapor into both nasal cavities by a Y-branched section and is out of the way of the surgeon. Full anesthesia can be first established under ether, then chloroform continued throughout the operation, the gauze pad being held in long forceps. The nose and fauces should be sprayed in advance with cocaine or bromide of potash solution, and a hypodermic given of morphia and atropine suited to the age of the child. Adrenalin and alum should be employed during the operation to lessen hemorrhage. Occasional inversion of the child will lessen the amount of blood and mucus swallowed.

Staphylorrhaphy.—Closure of the SOFT PALATE is performed by grasping the tip of the uvula with a pair of mouse-toothed forceps and with a thin very sharp bistoury paring the entire border of the V. Sutures are then inserted and the edges temporarily drawn together to ascertain the points of tension. The section of the tensor palati, close to the alveolus as it passes around the hamular process just behind the molar teeth,[1] or of the palatopharyngeus (Fig. 32, Piersol) in the free border of the velum is seldom required in simple cleft of the soft palate, nor will it be always neces-

[1] Agnew, System of Surgery, vol. ii, p. 977.

sary to separate the base of the velum from its attachment to the outer angles of the hard palate. These procedures add to hemorrhage and promote the formation of cicatricial tissue that interferes with subsequent good phonation.

Uranoplasty (Closure of the Hard Palate).—Brophy's technic[1] consists in forcibly crushing together *the superior maxillæ of the infant* by hand or by flat forceps. Then by strong needles, wires are passed through these

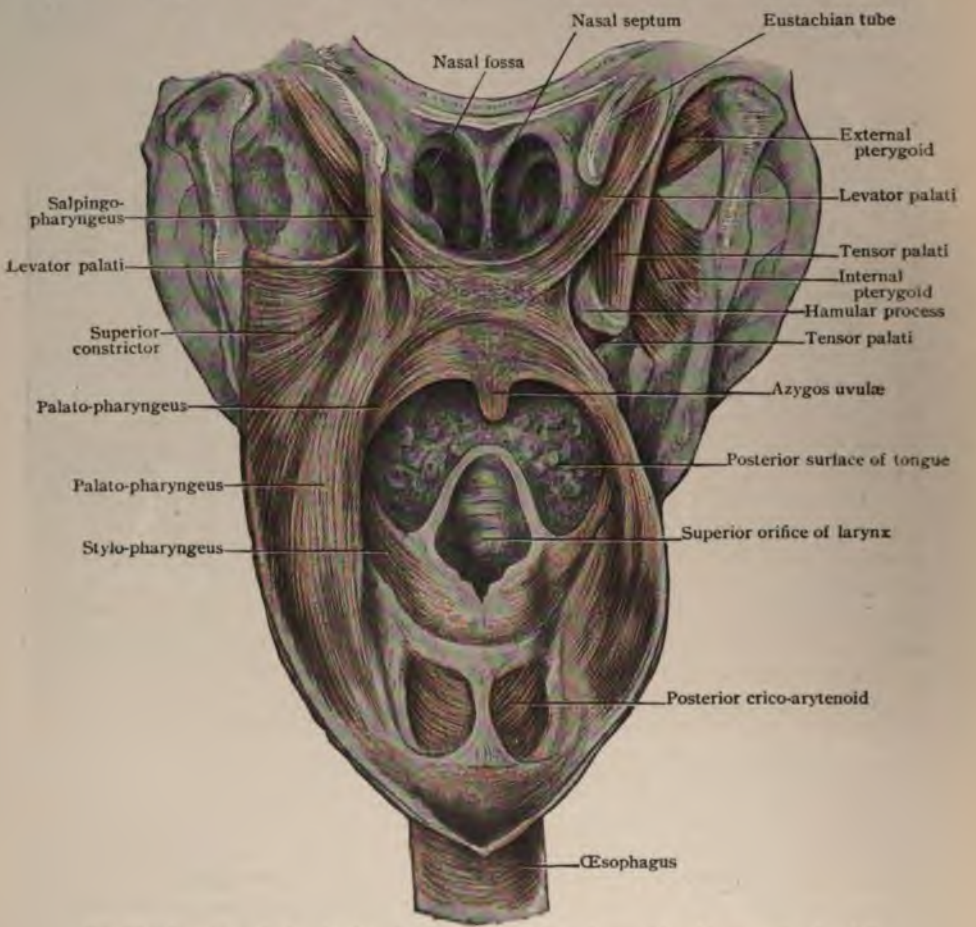

FIG. 32.—Levator palati and palatopharyngeus muscles, to be considered in operation for cleft palate. (Piersol's Anatomy.)

two bones from one side of the mucous surface above the alveolus at the fold where the gums join the cheek to the opposite side. This line is above the level of the hard palate and above the teeth germs. Perforated leaden plates are then applied between the gums and the cheeks on either side and the two wires twisted together over them, clamping the two bones as nearly

[1] Brophy, Trans. Amer. Surg. Assoc., 1904, 124; Jour. Amer. Med. Assoc., Aug. 24, 1907, 662; and Treatise on Deformities of the Mouth.

as possible to the median line. The wire tie-plates are retained for weeks. This forcible compression may produce a greenstick fracture up to six months of age, but after that period a saw or osteotome is necessary to weaken the body of the jaw above the alveolus. If the child is sufficiently strong, the edges of the cleft are pared and sutured at the primary operation, or may be closed by a second operation.

In delayed operations and in older cases a mucoperiosteal or muco-connective-tissue operation may be undertaken. After the edges have been carefully pared and freshened (Fig. 36), the soft tissues are thoroughly separated from the roof of the mouth by a handled strong periosteotome set at obtuse angles to the shaft (Fig. 33, *D*) and by a right-angled knife (Fig. 33, *B*) until the two flaps come easily in apposition. Bleeding may be lessened by mopping with adrenalin or alum solution.

FIG. 33.—*C* and *D*, periosteotomes. *B*, right-angled knife.

FIG. 34.—Curved staphylorrhaphy needles with handles.

The base or attachment of the soft palate to the bone should always be divided, to lengthen the velum. The edges of the cleft are thoroughly pared and tension sutures introduced by passing four fine silver wire sutures, introduced with handled curved needles of different angles (Fig. 34) at a distance from the cleft. Approximation sutures of horsehair or oiled iron-dyed silk or colored silkworm or fine silver wire are then introduced along the borders of the cleft. Upon these outer wire tension sutures, are fixed two perforated lead strips which splint the tissues and assist in relieving tension. The median border sutures are then tied or clamped with very fine shot.[1]

Owing to the failure of the simple flap operation, many modifications have been suggested. To relieve tension upon the tissues and permit sliding

[1] Dental Cosmos, April, 1901.

inward, the entire thickness of the roof of the mouth, including the periosteum, may be divided along the alveolus and separated from the bone by obtuse and right-angled periosteotome or raspatory. Less damage is done to the border of the cleft if this denudation is done from without inward, *i.e.*, FROM ALVEOLUS TO BORDER.[1] The division of the border from the bone should be made with a knife set at right angles to the handle. The flaps are secured by fine silver wire, or colored silkworm sutures clamped with very small shot, or tied with black iron-dyed silk sutures well anointed.

FIG. 35.—Flap from one side reversed, and sutured with raw face against raw surface of flap from opposite side. (Ferguson.)

Other surgeons loosen the periosteum and roof of the mouth from the border outward and then make lateral incisions sufficiently long to relieve tension and permit easy closure by suture.

Another method raises a deep mucocellular flap from the palatal plate as far out as the alveolus of one side and reverses it upon its uncut base at the margin of the cleft. The opposite flap is lifted from the edge of the cleft outward and is drawn across and sutured to the raw face on the first flap (Fig. 35). The author has been able even in adolescent cases where

[1] Sherman, Trans. Amer. Surg. Assoc., 1908, 609.

the bicuspids and molars have been lost, to successfully close wide clefts by chiselling and loosening the whole posterior alveolus and hard palate on either side and shifting the fragments inward to close the gap. Other methods divide the palatal plate on either side with a chisel and force the fragments inward after freshening the mucous edges.

Sherman,[1] in a sensible article for relieving strain, advises the plan employed by Mayo of supporting the flaps by passing a tape by means of a ligature carrier around the two flaps that have been loosened from the bone as far back as the junction of the hard and soft palates (Fig. 36). This tape is saturated with iodoform wax to prevent infection and is fastened by sutures (Fig. 37). Silkworm mattress coaptation stitches of the border ensure a wider line of raw surface approximation. The tape is removed in one week; the sutures in ten or fourteen days. The lateral gaping cuts are packed with iodoform gauze each day. He avoids the Brophy operation on account of the feeble resistive powers of young infants and the danger of ulceration, sloughing, and infection from the plates and sutures. He also advises that infants be sent home after operation rather than remain in the hospital. The mouth and nose should be kept clean by a spray of salt solution and the child fed by funnel and catheter through the nose to avoid infection of sutures.

FIG. 36.—Mucous tissues of the hard palate separated from the bone and secured by a tape *A A* passed across the nasal aspect of the flaps (Eastman).

Many surgeons divide the operation into two stages, first closing the soft palate and later uniting the hard palate. Others first separate the tissues of the roof of the mouth thoroughly from the bone and after two or three days, if the vitality is ensured, pare and suture both hard and soft palates.

In any operation the needles should be sharp, with keen cutting edges, and the ligatures small and well oiled. Unless the freshened edges are close together just behind the incisor teeth, an attempt to pass a handled curved needle through both flaps will often result in injury. It is better to pass the suture first from the oral surface TOWARD the nasal surface on one side and withdraw the short end of the suture from the eye of the needle with a small tenaculum or forceps. The end is then withdrawn from the mouth, rethreaded and carried on the opposite side FROM the nasal surface to the oral. In other cases a short ordinary curved surgical needle is employed to carry the suture first through one flap; it is then drawn out and passed through the opposite one. These methods are easier than inserting loops to draw the sutures.

Lane advises operation the day after birth for the reasons that the child's tissues are then in their most active condition for repair, that the

[1] Sherman, Trans. Amer. Surg. Assoc., 1908, 611.

operation is well borne, the hemorrhage moderate, and the risk of life small, also that later phonation is greatly benefited from the fact that the nasal cavity is developed and increased normally. Lane[1] claims that the hemorrhage is much less than in children between three and six. He also operates upon the harelip at the same time, utilizing lip flaps in seriously deformed cases to fill in the anterior palatal gap, and securing the pressure of the lip during the early formative months of life. His method interferes with the germs of the milk teeth, but does not injure the germs of the more important second set. His operation consists in raising a large mucoperiosteal flap by an incision extending to the OUTER FACE OF THE ALVEOLUS. The incision is made from the anterior apex of the cleft

FIG. 37.—Tape fastened and edges of flaps sutured. (Mayo, C. H.)

outward, thence along the OUTER face of the alveolus at its junction with the cheek. At the outer angle of the soft palate the incision abruptly turns toward the median line and continues along the free border of the soft palate to its tip. Both alveolus and the hard palate are then denuded inward to the margin of the cleft. On the opposite side a flap is lifted FROM the margin of the cleft OUTWARD TO or even BEYOND the alveolus if necessary. The first flap is REFLECTED UPON ITS BASE and inserted (raw face upward) BENEATH the raw surface of the second flap. When sutured in position this gives a double thickness to the flap, without tension. The large resultant raw surface speedily repairs. If the septum of the nose extends to the level, it may be denuded and the flap anchored to it.

An aluminum splint passing from one lateral incision around to the other, forming a bridge, may take off tension.[2]

[1] Arbuthnot Lane, Cleft Palate and Harelip, London, 1908, 42.
[2] Canadian Journal, Med. and Surg., June, 1907.

Instead of needles, Vance uses two hollow aspirating needles, one armed with double silkworm, the other with single. The first is passed from one side, the other from the opposite. The single thread is inserted in the loop, the needles withdrawn and the single suture pulled through.

After Treatment.—The infant should be quieted with bromides, paregoric, and other anodynes, and the parts sprayed with boric solution after each feeding. An argyrol or a protargol solution may be used. The stitches should be closely watched and removed as soon as they show any signs of cutting through, usually in from six to seven days. During removal of the stitches the child should be wrapped in a towel with arms firmly fixed behind the back. An assistant should grasp the head with both hands so that no sudden motions disturb the feeble line of union. Wire stitch loops are more difficult to remove than silkworm or horsehair or silk. Shot may be accidentally swallowed unless caught with rat-toothed forceps before the loops are cut with blunt scissors. Black silk or colored silkworm facilitates quick identification of sutures.

In older children, iced water, iced milk and cold broths may be employed with nutrient enemata. All talking must be prohibited, signal methods having been previously taught, or a tablet used.

Prognosis.—The surgeon should always warn the parents that even with the most careful technic, failure of adhesion is not uncommon and several operations may be necessary, especially in adolescents. Small openings in the palate after operation can often be finally closed by frequent touching with tincture of iodine to stimulate granulations. Long and patient subsequent speech culture by an expert will be required.

Brophy reports only 2 patients dead after 575 operations; while Bryant states that the mortality in cleft of soft and hard palate operations before the fourth month is 50 per cent. since many of the patients are poorly nourished.

Prosthetic Apparatus. — In adolescents and in adults, OBTURATORS constructed by a skilled dentist answer an admirable purpose and phonation is often better than after late operative interference, as tensor palati and palatopharyngeal muscles are atrophied from long misuse. The apparatus is made of vulcanized rubber with a movable velum.

ELONGATED UVULA.

An elongated uvula is usually temporary in character and may be stimulated to contraction by painting with a saturated solution of alum, or a ten-grain solution of nitrate of silver, or 1:1000 adrenalin. If permanent and productive of cough, it may be cocainized, seized with toothed catch-forceps, and the tip removed with blunt scissors.

SOFT PALATE WOUNDS.

The velum is sometimes torn completely through by falling upon a pencil or stick held in the mouth or by a button-hook or other object. Subsequent alteration of speech will be prevented by immediate anesthetization and suture of the muscle with black iron-dyed silk, carried through on a sharply curved needle, as in staphylorrhaphy (p. 41).

TONSILLAR HYPERTROPHY.

Hypertrophied tonsils of lymphoid structure folded into crypts and lined with epithelium frequently require removal when they obstruct breathing or interfere with phonation.

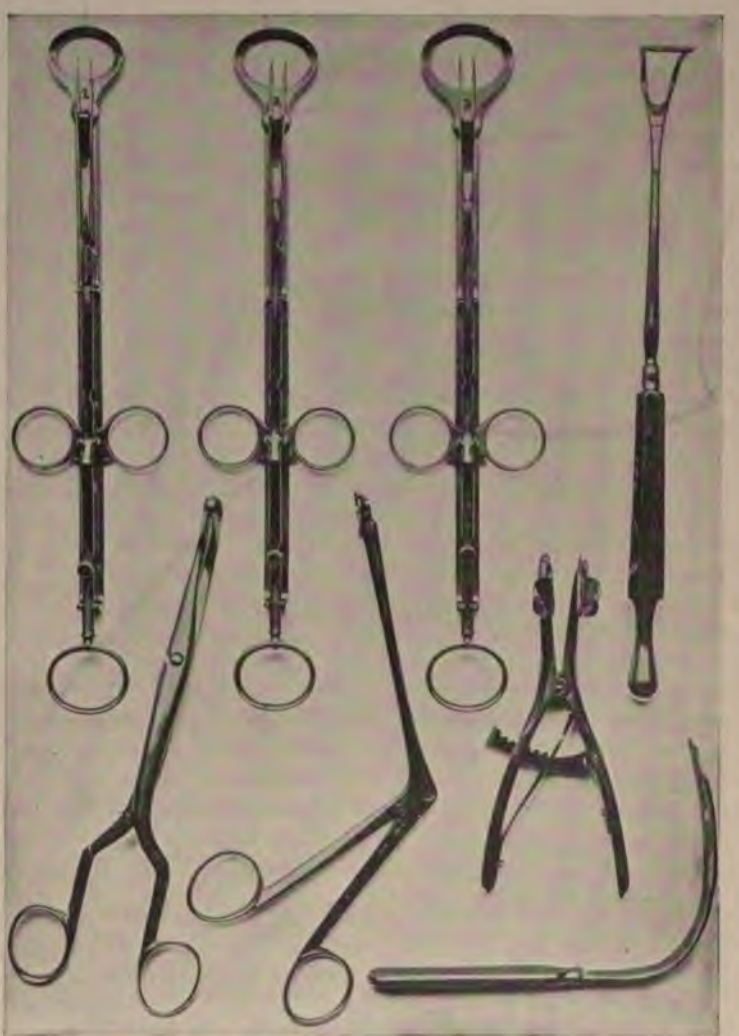

FIG. 38.—Instruments for tonsillotomy and adenoid operations. (Packard.)

Treatment.—A tonsillotome (Fig. 38) is the quickest instrument for the purpose. The region is mopped with a ten-grain solution of cocaine, then illuminated and the ring slipped over the tonsil and held in position with the left finger, while the concealed knife is quickly driven through a sufficient amount of tissue. Cocaine relieves pain, but rebellious children may be given nitrous oxide or ethyl chloride or ether through the nose

with an Allen's or Junker's apparatus. Blood and saliva may be removed by aspiration. If the tonsillotome is not at hand, the tonsil may be grasped with a four-pronged forceps, drawn toward the median line and divided with a blunt-pointed bistoury. If too much traction is made, or too deep a section made, the tonsillar branch of the facial or the ascending pharyngeal branch of the external carotid might be divided, in which case the external carotid should be compressed or tied, iced vinegar gargles used, or adrenalin and cocaine applied locally. Other operators enucleate with the finger, and snare. In the chronic conditions of tonsillitis, tonics, fresh air, etc., are of great importance.

Tonsillar Abscess.—Abscess of the tonsil following tonsillitis or quinsy should be opened if possible without general anesthesia, to prevent the pus passing into the trachea. A ten-grain solution of cocaine applied locally will diminish pain. The tongue is drawn forward and the throat illuminated. A straight sharp-pointed bistoury with blade wrapped with adhesive plaster to within a half inch of the point will prevent injury to the carotid. If the abscess is bulging through the velum, the incision should be made in front, parallel to the muscle fibres.

ADENOIDS.

Synonyms: Pharyngeal tonsils; lymphomata.

Adenoid growths in the vault of the pharynx are especially common in childhood. They may even be congenital and possibly hereditary, while nasal catarrh, chronic hypertrophic rhinitis, pharyngitis, and tonsillitis aid in their development.

FIG. 39.—Typical adenoid facies. (Packard.)

Lymphoid tissue in the upper pharynx resembling tonsillar tissue is called PHARYNGEAL TONSIL. It becomes more dense and fibrous as age advances and may or may not be associated with faucial tonsil hypertrophy.

Diagnosis. — The diagnosis of adenoids from hypertrophic tonsils is important, as mouth-breathing and obstructed air supply and altered voice are present in both conditions. With adenoids, the mucopurulent discharge from the nose is increased, the nasal sounds of voice are greater, hearing is impaired, and the broadened, flattened facial contour at the base of the nose and the high palatal arch are suggestive of the face of imbeciles (Fig. 39).

A posterior rhinoscopic examination with good illumination is essential, after which the location of the growths may be completed by the

stlessness at night, mouth-breathing, pigeon breast, spasmodic
ired oxygenation, and anemia are common results.

ent.—Temporization with astringent sprays is not curative.
ild being thoroughly chloroformed, is placed in the dependent
n, a mouth-gag inserted, and the masses thoroughly removed
l cutting curette (Fig. 40) or cutting forceps as detailed in
ks on Rhinology. Hemorrhage will be free, but may be lessened
n, by hot alum water or by iced vinegar.

FIG. 40.—Schütz adenotome.

TONGUE TIE.

t frenum is often more apparent than real. When, however,
annot protrude the tongue without a downward bend, the thin
frenum may be divided with blunt scissors while it is stretched
s or pair of clamp forceps. If only the thin band is snipped,
mainder of the loosening made with fingers, there will be no
ounding the lingual artery.

RANULA.

enital cyst presenting itself in the floor of the mouth, beneath
and on either side of the frenum, may be due to an obstruction
ne glands. As a rule the sublingual duct can be demonstrated
If the cyst increases in size, the entire sac must be dissected,
in young children is impossible.

NITAL DERMOID CYSTS in the floor of the mouth should be
he same manner.

APHTHOUS ULCERS IN MOUTH.

ous ulcers in the mouth usually occur from faulty digestion and
ality. Each ulcer should be touched with pure ether or with
lid sulphate of copper, while milk of magnesia, milk of bismuth,
, are given internally.

EPULIS.

in children is usually simply a granuloma from the gum, caused
d or diseased tooth, and requires only the removal of the offend-
he curetting of the growth and touching of the base with pure
d. Practically, it is never malignant in children.

MICROSTOMA.

A mouth narrowed by congenital defect or by cicatricial contraction after a burn, trauma (Fig. 41) or scarlatinous or diphtheritic sloughing (noma) may be enlarged by equilateral sections outward, first of the skin only, after which flaps are to be dissected from the buccal mucous membrane of sufficient size to cover the borders and angles and secure a symmetrical mouth. Fine iron-dyed silk sutures, well smeared with carbolized cosmoline, are best.

Faulty development of the mouth is due to a failure of the maxillary and the mandibular processes of the first visceral arch to properly unite during the fourth to sixth week of fetal life.

FIG. 41.—Cicatrix from wound of lip and nose.

MACROGLOSSIA.

Macroglossia (lymphangioma cavernosum), from dilatation of lymph channels and spaces, often causes the tongue to seriously enlarge, necessitating retrenchment.

DOUBLE LOWER LIP.

A double lower lip may or may not be angiomatous. It can often be improved by dissecting out the superfluous tissue and covering the border with a proper amount of mucous and cutaneous surface to preserve the normal contour.

ANGIOMATA.

Synonyms: Nevi; mother's-marks, birth-marks; port wine marks; vascular or telangiectatic or erectile tumors.

This class of vascular tumors is especially unpleasant when situated on the face but may occur on any part of the body. They may be capillary, venous, arterial, or mixed. At birth the dilatation of vessels and discoloration may be slight and remain stationary, or gradually disappear. In other cases the arterioles rapidly dilate, pulsate and form CAVERNOUS NEVI or ERECTILE TUMORS of red or blue color. The contents can be emptied by pressure but quickly return. NEVI PILOSA are covered with hair.

LYMPHANGIOMA are filled principally with lymph channels rather than blood and are colorless or slightly pinkish. MACROGLOSSIA is a lymphangioma of the tongue, consisting of dilated lymph-vessels. Stewart removed from an infant an enlarging lymphangioma extending from the upper lip to the parotid and from orbit to lower jaw. The skin was dissected back and all existing muscle fibres saved.[1]

[1] Trans. Phil. Acad. of Surg., vol. ix, 141, 153.

CAVERNOUS ANGIOMATA are rare, but the superficial subcuta-
ectatic cases are common, occurring from a tiny blue mother's-
wine-colored discolorations of large areas. The author has a
enting cavernous congeries of vessels over one scapula that
gerates the deformity of an existing lateral curvature. Ash-
a case of this variety[1] that extended from the right front of
the right scapula and over the shoulder, the whole area being
luish in color and of different degrees of elasticity. Muscular
lessened that a pencil could not be used in the fingers.

nt.—Superficial nevi often lessen spontaneously in size and
rth. If the tumor is receding, the surgeon can afford to wait,
y collodion or pressure, but if advancing, surgical measures
dertaken.

RE.—Compression with a button or coin wrapped in gauze
by adhesive strapping or elastic bandage if the tumor is
th bone may be helpful in any part of the body. Nitric acid
ethylate are not advisable.

OLYSIS.—Small angiomata and birth-marks are best treated
ic cautery needle under local cocaine or freezing anesthesia.
several of which may be attached to one handle to hasten
are insulated to a certain distance and are passed into the
tumor in a horizontal direction. A current of 30 to 40 mil-
m a galvanocautery battery is then passed through for three
utes until the tissues are cooked. If single needles are
le punctures are required under local anesthesia, the other
battery being attached to a sponge electrode placed on the
rge tumors repeated treatments will be required, according
nd vascularity of the growth. If the needle is slowly with-
antiseptic dressings applied but little hemorrhage, pain or
will follow.

WATER INJECTIONS.—Wyeth[2] successfully treats these tumors
l or local anesthesia by hypodermic injections of water heated
The liquid is introduced at many points deep into their sub-
ch the feeding vessels and coagulate the blood and albuminous
ecial metal syringe is required and care must be taken not to
n. Moderate birth-marks may require only a superficial in-
w drachms, but large cavernous nevi may need several ounces.
rface blanches, the injection should cease. When possible,
al compression should be employed to avoid the danger of
n a limb, a bandage is applied. Injections should be repeated
of a week until obliteration is secured. The method is not
ger of embolism.

CTURE.—For a large nevus in an unexposed region ignipunc-
e narrow blade of a thermocautery is rapid, the instrument
o reach all portions of the growth. The sloughing and gran-
eave a scar.

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st, Trans. Phil. Acad. of Surgery, vol. ix, 200.
Surg. Sec. Amer. Med. Assoc., 1903, 169; Wyeth's Surgery, p. 88. 2d Edit.

LIGATION AND EXCISION.—For nevi of large size on unexposed portions of the body, flaps of healthy skin are turned back and a dissection made well outside of the enlarged vessels. A chromicized catgut or silk or linen ligature is grasped with slender needle-forceps (Tait's) and passed deeply through the tissues well beyond one extremity of the tumor and dropped. An inch further on another ligature is carried through in a similar manner, dropped, and the free end of the first ligature seized and drawn back by the forceps to make a loop with its initial end. As many loops as are necessary to include the entire growth are thus deeply introduced, the adjoining free ends being tied tightly in succession. The skin flaps are drawn together and sutured loosely, catgut or horsehair drainage being introduced.

A growth of moderate size may be constricted by passing a double ligature through its centre and tying each half.

A large growth may thus be safely ligated without undue hemorrhage, as no supplying vessels can escape the loop ligatures thus introduced. Ligation of the skin around harelip pins leaves a scar and is liable to produce sepsis.

A CIRSOID TUMOR OF THE SCALP may be cured by raising the entire mass and scalp as a flap by a horseshoe incision and ligating all vessels except the principal one at the base which is permitted to remain. Antiseptic gauze is placed beneath the flap until its life is assured, when any pulsating vessels are ligated and the flap laid back in position.[1] Large cirsoid dilatations involving an entire extremity may be relieved by an elastic bandage, but if largely venous in structure the vessels may be excised or the principal supplying artery ligated.

INCISIONS AND CICATRIZATION.—Squire claims that birth-marks can be obliterated by freezing with ethyl chloride or ether spray and making numerous parallel superficial incisions, one-sixteenth of an inch apart. Firm compression over a sheet of blotting paper is then made for fifteen minutes, after which paper and clots are washed away with hot sterile water and an antiseptic dressing applied. At the second operation, the incisions are made crosswise to the first cuts.

Nevi of the lips can be excised by a V-shaped section and plastic suture.

EXCISION.—Excision of the vascular mass when it is circumscribed is the operation of preference. Under strict asepsis, flaps of the healthy skin are turned aside and a careful dissection made outside of the nevoid tissues, hemorrhage being controlled by pressure, by hemostatic forceps and by alum or adrenalin. When normal tissue is reached, the base is clamped and the feeding vessels tied with catgut, or the base may be divided with galvanocautery loop or thermocautery, preferably, however, by ligation, as primary union without necrosis of tissue is important, especially in the face. After the arrest of hemorrhage the skin flaps are laid back and an intracuticular suture inserted to avoid scar. Horsehair drainage will not be found necessary unless the cautery has been used.

[1] Bryant, Oper. Surg., vol. i, 190.

MOLES AND WARTS.

Moles, or pigmented dermoid patches upon the face, should be removed in childhood, as they are not only unpleasant and disfiguring, especially if hairy, but are liable to trauma and ulceration, and in later life may become the seat of malignant melanosarcoma.

Melanotic neoplasms originating in moles are occasionally met with in children. If not removed early, they are prone to bleed or to discharge an offensive bloody serum.

Treatment.—Hairy moles (Fig. 42) should be excised or destroyed by thermocautery or X-ray. Complete excision, under local or general anesthesia, leaves less scar than the cautery. With asepsis and an intracuticular stitch, the slight scar will be unnoticeable. Practically they are angiomatous growths and the incisions should be made outside of the dilated vessels (see p. 51). If large, a plastic covering should be secured.

FIG. 42.—Hairy mole of the face. Removed by plastic operation.

WARTS (VERRUCÆ).

These enlarged branched papillary growths of epidermic cells may be removed by daily rubbing with calomel or carbonate of soda and covering at night with glycerin saturated with salicylic acid. Chromic and acetic acid and sodium ethylate act favorably. If persistent, they may be excised. On the soles of the feet or the palms of the hands they cause both pain and disability, and are most quickly removed by nitric acid, healthy skin being protected. Nitric acid should not be used in exposed regions as it always leaves a bad scar. Chloride of zinc is an excellent caustic.

CONGENITAL FISTULA.

Congenital openings discharging a thin fluid and carrying eczema about the orifice may be situated at any point on the face, nose, lips, or ears. These tracks may be shallow or extend deeply behind the nasal or oral cavity, as they are due to developmental faults of germinal cells in the branchial arches.

Treatment.—As bismuth obstructs the X-rays, the extent of these sinuses may be outlined by injecting them with bismuth subnitrate, 1 part, and vaseline, 2 parts, and then employing the X-ray for demonstration. A probe can be carried to their depths, the walls of the sinus extirpated, and the track closed. If the tip of a nipple-like projection is present, it may be removed at the same time.

LYMPHANGIECTATIC CONGENITAL CYSTS are sometimes found beneath the mucous membrane of the cheek and may be extirpated from within the mouth.

CONGENITAL HYPERPLASIA of the lips may be due to thickening of lymph-vessels (lymphangioma), or to capillary nevi, or to thickened mucous membrane (double lip).

CONGENITAL FISSURE.

Failure of the midfrontal and lateral embryologic processes to unite is responsible for FISSURE of the cheek, which may be vertical, involving even the eyelid (COLOBOMA), or lateral (MACROSTOMA) when the upper branchial arches fail to join. Harelip and other deformities may also be present, or lymphangioma of the tongue (MACROGLOSSIA). The edges of these fissures should be freshened and sutured neatly with fine silk, or by intracuticular silver wire suture. In MACROSTOMA, or enlarged mouth, the extra mucous membrane should be dissected away sufficiently to make the new angle of the mouth correspond with the opposite side. All plastic operations on the face must be planned from an artistico-surgical standpoint, as any blemish in this portion of the body is unpleasant. PLASTIC SURGERY of the face is too large a subject to be properly discussed in this volume.[1]

CHEILOPLASTY for loss of tissue from burns or extensive sloughing following exhausting diseases is occasionally needed. The operation is performed upon the same principles as in plastics for adults, the method being fully described in Bryant's and other operative surgeries.

ANKYLOSIS OF THE JAWS.

Cicatricial fixation of the jaws occurs in children most frequently from traumatism or from noma or gangrenous sloughing.

While running with sharp sticks or pencils in the mouth, a child falls, driving the object through the cheek. If wooden, it may be broken off and remain undiscovered until after long suppuration it may appear externally or below the ear, the cicatrization infiltrating the masseter, temporal and buccal muscles.[2] Vigorous measures by manipulations, stretchings, cork and wooden wedges must be taken during healing to prevent contractions. If already ankylosed, efforts must be made under ether to separate the jaws by mouth-gags, screw-pressure, or wooden wedges. Unfortunately, the teeth are usually unable to bear the amount of pressure requisite to overcome the cicatricial contraction. These measures, both manual and instrumental, must be subsequently persevered in for months. A Barnes uterine rubber dilator placed between the teeth throughout each night and distended with water or air will assist in the separation of the jaws. In case of failure, the cicatricial tissues and masseter muscle may be divided and massage and manipulations continued to separate the jaws. In extreme cases the dense tissues may be cut away and a flap turned in from the cheek. As the ankylosis is seldom due to fixation at the articulation, excision of a portion of the neck of the ramus, with turning in of a flap of fascia in order to secure a false joint, is rarely required.

FOREIGN BODIES IN THE NOSE.

Children are very fond of pushing beads, buttons, kernels of grain, and various small objects into the nose. Insects also may make their way into the cavity.

[1] J. B. Roberts, Plastic Operations on the Face.

[2] Willard, Ankylosis of the Jaw, Ann. Surg., 1904, xxxix, 451.

nt.—If blowing the nose fails to dislodge the offending body, he opposite nostril or snuff should be employed to compel owel being placed to prevent the object escaping from notice. water from a fountain syringe carried through the other nos- e head is held forward may also dislodge it. If out of sight, nasal speculum and head and throat mirror may bring it into ceps with tiny teeth be slipped alongside, or a bent probe or e inserted. Cocainization is usually sufficient but etherization ssary with young or nervous children, in order that a thorough ade. If long retained *in situ*, ulceration and a purulent dis- result.

NASAL POLYPI.

olypi are rare in children. These tumors consist of mucous ubmucous connective tissue and may spring from turbinated n the septum or ethmoid. They are benign in character, but ously with breathing and with speech.

ugh examination of posterior and anterior nares with nasal d mirror, finger and probe will determine their location and m from hypertrophy of the mucous membrane or of the in- ated bone.

n.—After flushing the nose with boric solution and cocain- oughly, a stiff wire snare ecrazeur is slipped over the tumor, tightened slowly. If a portion remain, it can be looped sec- e snare being dexterously carried along the septum or floor st suited to the tumor, or forceps may be used. Tumors n the posterior nares will require throat illumination and and adjustment of the snare with the finger. The cautery substituted. Iced vinegar or alum or adrenalin solution will rhage. The nostrils should be kept clean by subsequent gentle shings and sprayings.

SHORT SEPTUM NASI.

nitally short septum nasi inturning the tip of the nose may be y splitting the skin along the under edge in a Y-shape. The artilage are divided upward and backward with strong scis- w chisel, the nose elevated and retained by a double barrelled silver or aluminum tube. Subsequent anteroposterior stretch- ivalve nose speculum will prevent contraction.

or DEFICIENT SEPTUM NASI results when the fourth nasal to push down between the lateral maxillary processes. The ally associated with harelip.

AL BONES or even the nose may be ABSENT. Plastic operation ken from forehead, cheeks, arm, or the transplantation of a stal cartilage, while producing a very imperfect organ, yet is ent upon an open cavity.[2] Prosthetic apparatus is sometimes able.

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[1] Finney, Trans. Amer. Surg. Assoc., 1909, 298.
[2] J. B. Roberts, Plastic Operations on the Face.

DEVIATED SEPTUM.

Deviations of the septum nasi occur congenitally or from abnormal growth or from blows upon the nose. Either cartilaginous or bony septum or both may be forced aside, or the cartilage dislocated. The obstruction to the nares not only interferes with breathing but imparts an unpleasant tone to the voice. Associated with fracture of the nasal bones there may be also external deformity of the bridge of the nose.

Operation. — After flushing the nose with boric acid and applying cocaine, the septum may be forcibly carried into proper position by a pair of flat-bladed nasal duck-bill forceps. The septum is retained for a few days

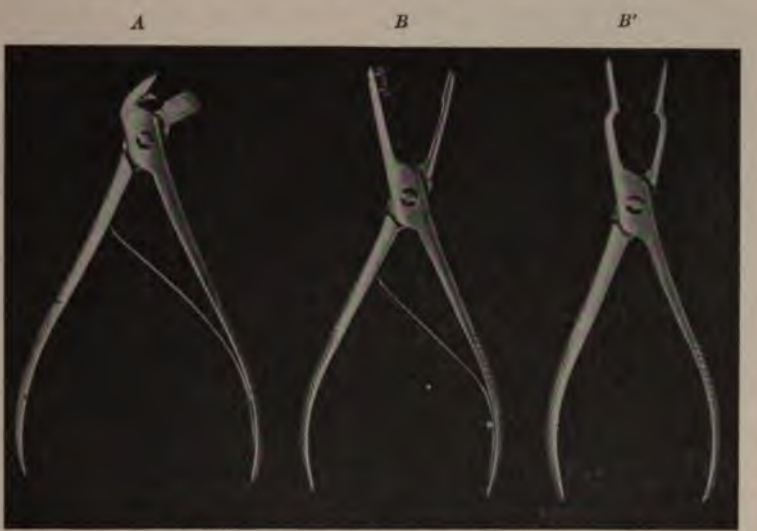

FIG. 43.—*B*, nasal punch. *B'*, nasal duck-bill forceps.

with loosely applied short clamps or rubber tubular nasal splints. If too stiff to be corrected, the vomer may be weakened by nasal punch (Fig. 43, *B*) or by knife or saw or special scissors and molded into straight line by forceps (*B'*) and finger.

A DISLOCATED TRIANGULAR CARTILAGE may be cut loose from the bone, forcibly brought to position and held there for a week by fixing it with a short stout steel pin.

EPISTAXIS—NOSE-BLEED.

Hemorrhage from the nose, if slight, may often relieve a congested brain. If severe, however, it may be checked by applying ice to the nose, forehead, and back of neck. If clots are washed away by sniffing up water the bleeding will continue. A simple plan always available is to lean forward with elbows resting on the knees, thus gaining gravity to assist in fixing the clot. The nose should now be closed by the fingers, and breathing maintained through the mouth for FIVE MINUTES BY THE CLOCK, not by guesswork. During this time a coagulum will be formed that should not be disturbed for hours. By following this plan for more than forty years

as not been obliged to plug the nostrils. Vinegar poured up while the head is inverted backward is usually effective, or a on of alum or adrenalin may be carried in on a thin cotton salts are not advisable.

ERIGERON CANADENSIS, gtt. x on a lump of sugar taken every is almost a specific for the emergency and in similar doses a day is remarkably effective in the chronic condition of re- ings. The general health must also be improved.

me cases, the anterior nares may be plugged from in front pledgets soaked in vinegar or alum or adrenalin and attached The posterior nares may be plugged by a special spring in- ellocq's canula). As this is rarely at hand, however, a very ER, threaded with a long double silk or linen thread, may be the floor of the nose into the pharynx, where the thread may ith forceps and drawn out through the mouth. One of these then be attached to a plug of cotton soaked in the solution, back through the pharynx until the pledget can be packed erior nares with the finger. The other thread attached to the ured at the angle of the mouth for withdrawal purposes.

attached to a doubled long silk or fish line may be dropped or of the nose, while the child is lying on the back. It is then e pharynx and pulled forward for the attachment of a cotton withdrawn through the posterior nares as before described.

DEFORMITIES OF THE NOSE.

asty.—SUNKEN NOSE in children is the result of hereditary trauma.

improved a sunken nose by introducing a tenotome through dividing subcutaneously all the soft parts attached to the ening. The nose was then pulled forward and a $\frac{1}{8}$ inch longi- ion made in the median line, below the bony bridge. With ger in the nose, the skin and mucous membrane were separated on each side of the base of the alæ of the nose. Two strips rtilage were cut from the lower thorax and drawn through subcutaneous tunnels. Similar strips of cartilage are in- the bridge downward toward the tip of the nose and also alæ if necessary.

FOREIGN BODIES IN THE EAR.

are very fond of pushing beads, beans, and like objects into canal, and bugs, insects, spiders, etc., may take refuge there lodged.

xamination with aural speculum and strong light, the canal e filled with glycerin or oil to kill any living insect. A gentle apy water from a fountain or other syringe is then introduced, being gradually increased. Should this method fail, under

[1] Binnie, Trans. Amer. Surg. Assoc., 1908, 379.

cocaine small delicate forceps or a wire scoop may be cautiously introduced alongside the object, and the canal being illuminated with head mirror the foreign body is withdrawn, great care being taken not to wound the drum or the canal. A small gimlet may be introduced into a bean or pea. A steel object may be removed by a powerful magnet.

DEFORMITIES OF THE EAR.

SUPERNUMERARY AURICLES and PENDULOUS APPENDAGES to the ears occasionally occur. For the sake of the mother they should be removed under local anesthesia as soon as the child is strong, sufficient skin being retained to preserve normal contours. If the MEATUS is closed, the canal may be sought for by dissection, but the canal is usually absent when the pinna is wanting. Keloid occasionally follows operation (Fig. 44).

FIG. 44.—Keloid degeneration of lobe of ear following operation.

BROAD AND FLARING AND PROJECTING EARS.

Large ears standing far out from the head, like the ears of a bat, are very disfiguring and unsightly. In an infant the condition may be corrected by frequent compression, by care in adjusting the ear while lying and by compresses held in place by a night-cap while sleeping.

If persistent, in older children a V-shaped section of skin and cartilage is taken of sufficient size to secure a normal contour.[1] A small needle and silkworm or celluloid thread anointed with carbolated cosmoline is used for suturing. A sterile compress and bandage is employed for ten days.

Acquired Deformities.—A CHONDRITIS of the ear, resulting in permanent deformity, may develop during an attack of acute articular rheumatism and several of the joints become permanently stiffened.[2]

TRAUMATISMS and VICIOUS BITES are liable to be followed by chondritis and deformity, with suppuration and necrosis of cartilage, unless the pus is promptly evacuated.

HYPERTROPHIES also greatly disfigure a patient and should be remedied by plastics to reduce the unsightliness.

EARACHE.

A frequent cause of earache is traumatism from foreign bodies, living insects, violent blows, surf bathing, or the use of hairpins to remove wax.

Earache is also common in many exanthematous diseases, as measles or scarlatina. Inflammatory conditions, furuncles, and chondritis frequently produce pain.

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[1] J. B. Roberts, Deformities of the Face.

[2] Levi, International Med. Mag., Sept., 1903.

irrigation with boric or carbolated solution, hot water bags, ıudanum, the washing out of cerumen, cocaine, and vapor give relief. Furuncles should be lanced and anodyne nents of carbolic acid or adrenalin with boric acid washings continued eruptions of boils, a vaccine of *Staphylococcus* employed. Polypi must be removed.

IMPACTED CERUMEN.

EAR WAX is a common cause of earache. It can be softened oil dropped into the ear for two or three nights and allowed ter cocainization the canal is irrigated with water as hot as and cotton soaked in laudanum, sweet oil, and cocaine is in the tube. A hot water bag can be used externally. If made to remove hardened masses by an ear-spoon damage ay result.

OTORRHEA.

t discharge from the ear is common after the exanthematous ıay proceed from middle-ear disease, perforation of mem- oid disease. The cause must receive thorough examination

:DIA and INTERNA and MASTOIDITIS are so serious in their e services of a skilled otologist are desirable. Diffuse septic idermal and brain abscess, and sinus thrombosis are not

CHAPTER III.

SURGERY OF THE NECK AND CHEST.

TUBERCULOUS LYMPHADENITIS OF THE CERVICAL GLANDS.

Synonyms: Tuberculous cervical adenitis; tuberculous lymph-nodes; scrofulous neck.

CLOSELY connected with the condition known as lymphatism and often associated with enlargement of the lymphoid tissues in the nose and throat, tonsils, or adenoids, the cervical glands become indurated or suppurative. The condition was formerly known as SCROFULOUS or STRUMOUS NECK (King's Evil). The disease is most commonly met with in children between three and ten years of age.

Etiology.—The tubercle bacillus is the infecting agent, yet hereditary germ defect with non-resistant cell power is usually present. Aggravation by bad hygienic surroundings and especially living in the room with tuberculous parents yields a condition of further disastrous receptivity. The infection may be received from face, nose, mouth, or throat.[1]

Anatomy of Lymph-vessels and Nodes.—The infection will follow the direction of the lymph current.[2]

The afferent lymph-vessels usually enter at the concave or hilum side of a lymph-node, the efferent depart from the convex side.[3] The lymph-nodes in the neck are the superficial cervical and the superior and inferior deep groups. The external jugular nodes lie upon the sternomastoid below the parotid gland. They receive lymphatics from the ear and parotid region and open into the superior deep cervical. The anterior cervical nodes receive the channels from the larynx and trachea and their efferent channels connect with the lower superior deep cervical nodes. The superior deep cervical glands, a dozen or more, extend along the course of the internal jugular from the mastoid to the omohyoid. They lie beneath the sternomastoid and receive efferent channels from the parotid, submaxillary, submental, retropharyngeal, and posterior parotid region and superior cervical nodes.

The posterior nodes receive afferent channels from the upper posterior neck and the occipital region.

The anterior nodes receive the lymph-vessels from the tongue, nose, palate, upper pharynx, esophagus, and the deeper portions of the larynx, trachea, and thyroid. The lower nodes of this plexus empty into the inferior deep cervical nodes (Fig. 45).

The INFERIOR DEEP CERVICAL and SUPRACLAVICULAR NODES rest upon the scalene muscles and brachial plexus. They receive channels not only from the superficial nodes but also from the vessels in the occipital region and posterior neck which follow the posterior border of the sternomastoid.

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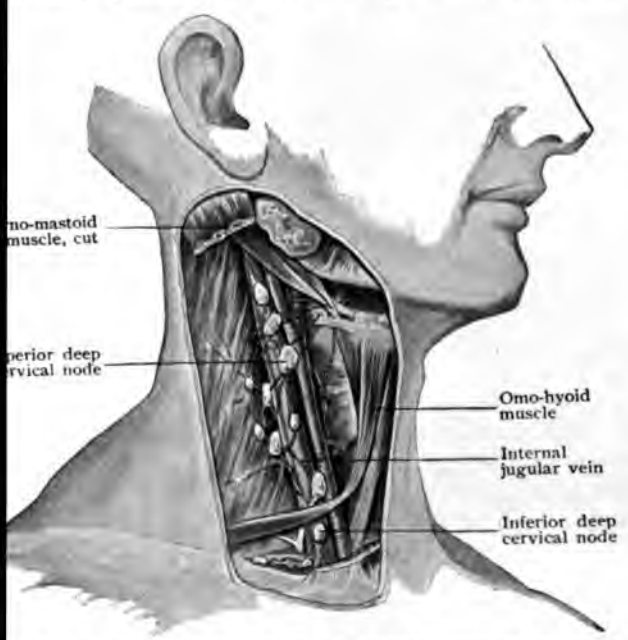
[1] Phipps, Tuber. Institute 4th. Annual Report, 1907.
[2] Gerrish, Trans. Amer. Surg. Assoc., xiii, 1895.
[3] Archives d. Mikros. Anat., Bd. 63, 1904.

ive efferents from the pectoral region, the arm, the axilla, the liver through channels that follow up the internal mam- Uniting with the channel from the superior deep cervical JUGULAR TRUNK, which empties into the thoracic duct or avian vein.

from the mastoid region, ear, and outer cheek and soft ch the parotid group. Afferents pass to the upper nodes of eep cervical group. Infection from the buccal, labial, nasal, gions, gums and tongue will reach the submaxillary glands. of these glands open into the superior deep cervical nodes at



5.—Deep cervical lymph-nodes lying on the carotid artery and internal jugular vein. (Piersol's Anatomy.)

on of the carotid artery. Infection from the lining of nose and th reaches the submaxillary and deep cervical glands. From ynx, and trachea, efferents enter the upper deep cervical, the y, and parotid group. The deep cervical glands follow the n below the sternal border. Afferents from the cheek, lower r of the mouth empty into the submental, thence into the sub- nd superior deep cervical.

ter pharyngeal nodes receive afferents from the upper part of x and mucous membrane of the nose and their efferents pass r deep cervical nodes.

erent vessels from the suboccipital, mastoid, and parotid regions perficial cervical nodes from which their efferent vessels empty ervical nodes.[1]

[1] Piersol's Anatomy, p. 947.

Pathology.—The myriads of tuberculous bacilli floating in the air find ready resting grounds in the nose, mouth, fauces, tonsils, and other lymphatic tissues, or in scratches on the face. If not destroyed, they follow the current of the lymph channels and meet their first station of arrest in the lymph-nodes. At once the battle commences; hyperemia followed by active phagocytosis on the part of the leucocytes and connective-tissue corpuscles may give victory and a return to normal conditions,—with resolution or absorption. In normal children whose resistive powers have not been weakened by hereditary germ defect or unsanitary environment, or temporarily reduced by exhausting disease, victory may follow. With partial failure, small grayish-white spots of tubercle appear which coalesce as the process extends. Without mixed infection the advance may be slow, with adhesion to surrounding tissue and tardy progress toward the skin. The deposition of epithelioid and giant cells may result in caseation and encapsulation and induration with thickening of connective tissue (p. 368). Defeat will result in necrosis of many cells and in suppuration, but with pus formation destruction of the foe is possible. Should the invading bacilli elude the first line of sentinels and reach the second row of glands, the resistive process is repeated, or the poison or its toxins may be swept into the blood circulation and invade epiphyses or other vulnerable tissues. In some instances infection with pyogenic microörganisms and prolonged suppuration may rid the system of the invader, but the process is tedious as the undermining procedure leads to extension of the disease and repeated outbreaks, even after apparent healing.

Symptoms.—The first symptoms recognized by the mother will be a small hard nodule in the neck, perhaps sensitive, frequently unaccompanied by pain. One, two, or a long chain of glands from the mastoid to the clavicle may be subsequently enlarged and indurated, according to the point of entrance of the infection. At a later stage, these glands may be soft and fluctuating, or some will be hard and others soft.

Diagnosis.—In purely tuberculous cases no previous throat symptoms may have been noticed and the enlargement and induration may progress for weeks or months. In doubtful cases the tuberculin test may be tried (p. 375).

Simple Chronic Adenitis.—In the diathesis known as lymphatism, both sides will, as a rule, be affected; the glands slowly enlarge and do not caseate or suppurate; they do not become adherent; iron, potassium iodide, arsenic, and the X-ray therapy with good hygiene may cause their disappearance.

Acute Septic Adenitis.—Following scarlet fever, typhoid, diphtheria, or any exhausting disease, an acute septic invasion of the cervical glands is common by absorption of pyogenic germs from the nose and throat.

Hereditary syphilis will present symptoms other than glandular swellings. In adolescents, direct syphilitic infection from lips or mouth is usually acute and involves a single gland. The primary sore is ordinarily discoverable.

Lipomata and myomata and benign tumors are usually single. Lymphadenoma will be accompanied by splenic enlargement and change in the white corpuscle proportion. Lymphosarcoma is rare, as also is hyperthyroidism in childhood.

—Temporary resolution followed by remission is common in
ng tuberculous glands. Their existence is always a menace
al, as the toxins from caseating masses may be swept into
culation at any period following a slight traumatism or
ease. Pus infection sometimes destroys the tuberculous
ntaneous evacuation of pus leads to long and tedious suppu-
st unsightly scars, while tuberculous meningitis or other
terward may destroy the patient. Infection of joints and
curs in many cases. The progression along a chain of glands
e or mediastinum is not uncommon and leads to extensive

is not productive of death in the majority of cases. Sixteen
ter of tuberculosis in other organs,[1] consequently early opera-
sirable. Early operation before suppuration has taken place
rimary union with intracuticular suture leaves but little scar,
rations are very severe and tedious and the results more or
although less conspicuous than spontaneous evacuations.
t.—A slow hyperplasia of superficial glands may often be
e prompt removal of the patient from all deleterious surround-
establishment of a healthy out-door life night and day in
shore, or forest. Tubercle bacilli die in sunshine; they thrive
d filth. If a sanatorium is selected it should be one adapted
ses, never one inhabited by phthisical patients; 25,000 doses
air yielding 4,000,000 to 5,000,000 cubic feet in the twenty-
e infinitely better than three doses daily of nauseous drugs
roy the appetite,[2] not improve it (p. 380).
s of cases should not be in a hospital but should spend the
unshine and the nights on a PORCH, or in a SHACK or TENT.
cult to protect against cold, but thunderstorms and snow are
some. As this class of cases are walking patients, usually
lly care for themselves, the problem in the case of the rich
l; for the poor, the difficulties are many. Merely "sending
o the country" is of little use unless arranged with care, since
are often most unsanitary, food poor, and sunshine rigidly
n the houses (p. 384).
SCHOOLS properly regulated are useful. DAY CAMPS near
give at least partial respite from unhealthy surroundings.
IPS are still better. TENTS are hot in summer and, if closed,
d in winter. Shacks and bungalows are better. For private
es are best, open in summer, partially glass enclosed in winter.
sible to secure these advantages, WINDOW TENTS at night will
erable amount of fresh air (p. 383).
nal cell nutrition is the essential element in successful repel-
undance of good food is required, but to the extent only of
Butter is better than codliver oil. Cream, milk, and eggs

N. Y. Med. Journ., June 23, 1892.
Open Air Treatment, Trans. Internat. Cong. Tuberculosis, 1908, vol. ii,
i; Open Air and Sunshine for Surgical Tuberculosis, Jour. Amer. Med.
, 1903; Tr. Amer. Med. Assoc., 1880.

are excellent, but never to the overtaxing of the digestive organs. Iron, iodine, arsenic, pepsin are helpful. The nose and throat should receive careful examination and continuous antiseptic treatment to prevent further infection. Iodine may be driven into the glands by cataphoresis, but injections have not proven advantageous.

RÖNTGEN RAY and FINSEN LIGHT therapy have promoted resolution in some cases.

Serotherapy, under control of the opsonic index, has a beneficial influence (p. 392).

INCISION.—If patients refuse radical operation, they should be notified that spontaneous evacuation or incision and drainage will necessarily require a long period of time and leave disfiguring cicatrices.

Under nitrous oxide or ethyl chloride anesthesia, glands that have already suppurated may be incised, broken down tissue curetted and the cavity mopped with pure carbolic acid followed by alcohol and packing. If infection of new tissue occurs and undermining sinuses form, they must be slit open to their full extent and treated in the same way. Sluggish sinuses may be injected with tincture of iodine or Lugol's solution; bismuth and vaseline injections are also exceedingly helpful (p. 400).

EXTIRPATION. — Thorough asepsis is essential. The mastoid region should be shaved, and the patient wrapped in cotton, placed on an electric heated mattress on the table to prevent shock and loss of bodily heat. Chloroform or ether may be used, preferably the former if an artificial light other than electricity is to be employed.

When several glands are involved, early removal before suppuration occurs should be the rule, thereby relieving the system from danger of infection and resulting in less disfigurement. If glands are already broken down, the suppurative stage is shortened. An early operation is a simple procedure, the glands are easily shelled out, and recovery with slight scar is secured by the use of the intracuticular suture. A late operation, with the entire chain from ear to clavicle infiltrated and adherent to surrounding tissues, even to the carotid and jugular, with gland after gland appearing deeper and deeper, is a procedure that Fenger well denominated as severe upon the surgeon as on the patient. No surgeon should enter upon such a tedious dissection without full knowledge of the anatomy of a region containing so many important structures and which may, before completion, present unexpected difficulties (Fig. 46). In former days, when operating in private houses was the rule, the author vividly recalls on one occasion the approach of darkness, when internal jugular, common carotid, and pneumogastric were in close contact with glands still unremoved. The complications were still further increased by the bursting into flames of the ether cone from the necessary oil lamp, but the dissection was completed.

The incisions will vary according to the position of the diseased lymph-nodes to be removed.[1] When possible, they should be BEHIND the sterno-mastoid rather than in front, as the scar will be less noticeable. For the submaxillary region, the natural skin fold separating the jaw from the neck should be followed. Some surgeons make long S-shaped incisions, turning

[1] Beck, Trans. International Congress Tuberculosis, 1908.

off large flaps and dividing the sternomastoid muscle. This of course gives wide exposure but is seldom necessary. Two incisions are often better than one. An incision from mastoid to clavicle, with cross cuts at the extremities where the scars will be concealed, will usually suffice even for extreme operations. If the chain of glands is first dissected from above the clavicle, carefully avoiding the top of the pleura, the subclavian vessels, the pneumogastric nerve, and the internal jugular vein, the dissection can be continued upward, removing the entire chain in one mass. The internal and if possible the external jugular veins are drawn toward the median

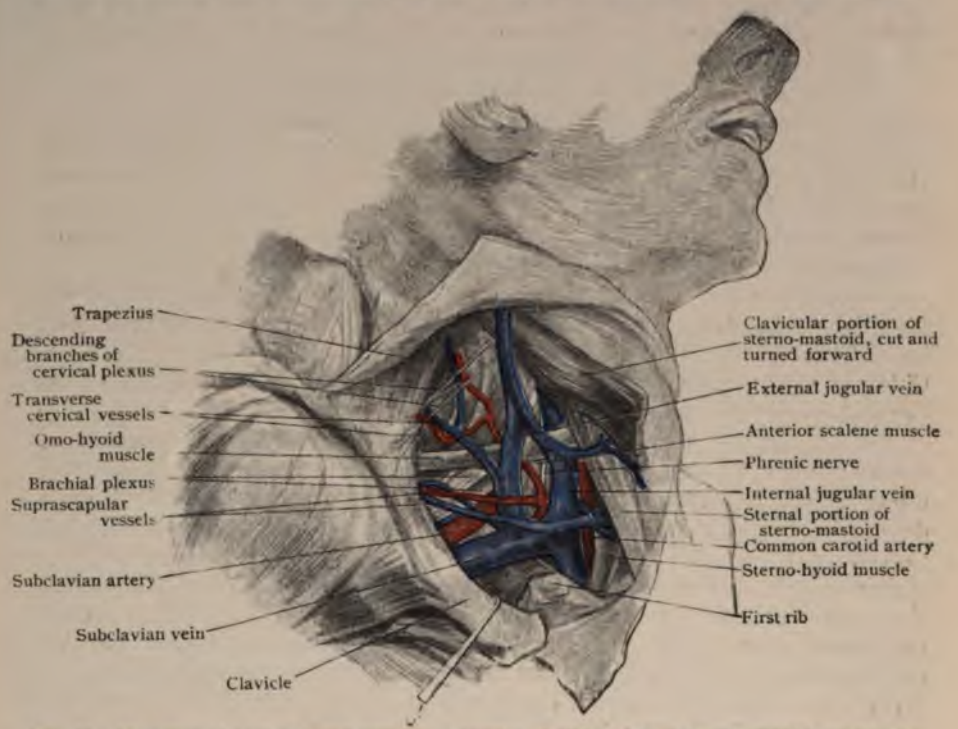


FIG. 46.—Dissection of neck, showing relations of vessels; clavicle has been disarticulated from sternum and drawn down (Piersol's Anatomy).

line with the sternomastoid, and the dissection slowly worked upward. Lines of cleavage if they exist should be followed. The capsule should be extirpated with the gland whenever possible. If the capsule is adherent to the wall of a large vein, the gland should be shelled out from the capsule. Blunt dissection with handle of scalpel or dry dissector or blunt scissors is safer than the knife.[1] Tissues are best separated by inserting the point of scissors and opening the two blades outwardly. If too much traction is made, the vessels may be drawn from their beds and wounded accidentally. If the vein is kept in sight, it is less liable to be injured. Veins torn off near the jugular will give large hemorrhage. Plenty of hemostatic

[1] Willard, Surg. Treat. of Tuber. Glands of the Neck, Trans. Amer. Surg. Assoc., 1896, 163; Annals Surg., xxiv, 669, 1896.

forceps must be at hand. If the internal jugular or other large vein is injured, the finger must at once close the opening to prevent the entrance of air, as such an accident might prove fatal. Forceps should be applied to the proximal end and the vein tied above and below or sutured at once laterally with fine catgut or silk coated with petrolatum. Artificial respiration should be practised if necessary. Injury to the pneumogastric or to the descendens noni—the phrenic—is rare, but even disturbance of these nerves tends to induce shock and subsequent pneumonia (Fig. 57, p. 80). Serious injury to the pneumogastric, while not necessarily fatal, is a dangerous complication, favoring bronchopneumonia or edema of lungs. In Park's list of injuries of this nerve, eleven out of thirteen died.[1] Interference with the phrenic is serious, and if this nerve is accidentally divided it should be at once sutured securely. Accidental injury to the brachial plexus, or laryngeal nerves, ought not to occur, yet has happened. If the carotid should accidentally be cut, lateral or end-to-end suture (Sweet) would become necessary. No undissected gland should be left unless the danger of removal is too great. Cautiously continuing the dissection upward the submastoid region will be reached, and in working at the parotid group, care must be exercised not to injure this gland or the facial nerve. Even a temporary facial paralysis is distressing both to surgeon and patient, and may require a subsequent anastomosis with the hypoglossal. A large vein torn close to the cranium may be clamped with forceps which can remain in place for forty-eight hours. The spinal accessory and motor branches of the cervical plexus must be located in this upper cervical region and avoided. If injured, they should be at once sutured lest atrophy follow (Fig. 47).

FIG. 47.—Atrophy of muscles in right supraclavicular fossa, from injury of nerves.

An unfortunate occurrence, when one has carefully removed a long chain of nodes, is to have a deep suppurative one burst and cover a previously clean wound. Immediate sponging and flushing, followed by the application of as strong a solution of carbolic acid as will be warranted by the structures exposed, may prevent infection of the raw surfaces.

When operative relief has been neglected and many deep glands have suppurated and all the connective tissue is infiltrated, clean removal is impossible, but every node that can be shelled out, even without its surroundings, should be removed.

The upper deep cervical nodes which lie in close apposition to the internal jugular vein and the bifurcation of the common carotid are best reached behind the sternomastoid. The lower group lie beneath the sternomastoid close to the internal jugular vein and the subclavian and trans-

[1] Park, Tr. Amer. Surg. Assoc., 1895.

veins. The chain may extend beneath the clavicle and con-
mediastinal vessels, making the dissection difficult and
he surgeon rarely fails to find more deep infected glands
arent on external palpation. Early location of the internal
the operation is advisable (Fig. 46).
neck wound may be closed with intracuticular silver wire
nterrupted silkworm gut. The platysma should be sutured
ıing of scar. Contaminated wounds should be drained with
split or cut spirally to lessen pressure upon vessels; also
ips or horsehair. If a dead space results above the clavicle,
lrained and a pad applied. A voluminous sterile dressing
ıd firmly with many turns of a stiff muslin bandage, in order
splint the neck. In rebellious children, a plaster bandage
ıs. Danger of exposure at the mastoid end of the wound is
overing with thymol di-iodide (aristol) and collodion and
upper edge of the gauze dressing with adhesive plaster, thus
›sure of the head in the bandage. With restless children,
.ons are never disadvantageous.
ɪEATMENT.—Drainage should be removed at the first dressing,
ıubsequent persistent sinuses must be opened or curetted, or
cted with iodine or with bismuth paste (p. 400). The aqueous
line seems more effective than the alcoholic, possibly because
kes a layer of coagulated albuminoid tissue. If other series
es having escaped notice should enlarge, a second or third
l complete the cure.
ıdular injections of chloride of zinc or iodoform are useless.
e, a silk FILIFORM SETON is used, it being claimed that the
onspicuous.[1]
IONS.—Care should be taken not to tear openings in veins.
ɾessels should be caught above and below and ligated. Rup-
rating glands should be avoided by shelling them out if pos-
perficial nerves should be saved. Division of the sternomas-
avoided, as deformity sometimes results; but, if divided, it
ɨly sutured with catgut. It can be retracted forward. The
.ar has been tied in a number of cases, but the proportion is
parison with the number of operations.

SUMMARY.

culously infiltrated cervical lymph-nodes are always a menace
:he individual.
ɜ earliest manifestations, infection may be arrested by an out-
ıt and day, with good food and hygienic surroundings.
operation before pus has formed is essential, as the pro-
n simple and leaves but little scar.
extirpations of a chain of lymph-nodes from mastoid to
severe and difficult operation, especially when infiltration

[1] Kirmisson, Précis de Chir. Inf., 1906, 683.

and suppuration have taken place. Injury to blood-vessels or nerves may occur.

5. Excision should be thorough and repeated if necessary.

6. Local applications have but little influence upon the infection.

INFECTIOUS OR SEPTIC ADENITIS.

Non-tuberculous infiltration of the cervical lymph-nodes is common in children from any infectious condition in nose, mouth, or fauces. These infections usually go on rapidly to suppuration. The diagnosis at first from tuberculous glands, lymphosarcoma and Hodgkin's disease is not always easy. The nose, throat and mouth should always be closely inspected and treated.

The infections from scarlet fever and other exanthemata often seriously threaten life from sepsis and from pressure on trachea or vessels. The author has seen such extensive sloughing, in neglected cases where tension has not been relieved, that it had laid bare all the great vessels of the neck and required ligation of the jugular.[1]

Treatment.—Early and free incision under local anesthesia is important to relieve tension, followed by liquid carbolic acid and alcohol or 2 per cent. formalin.

The application of a suction cup followed by antiseptic drainage will speedily relieve the septic symptoms.

SIMPLE LYMPHOMATA.

HYPERTROPHIED GLANDS, non-tuberculous, may exist as one or many enlargements along the course of or behind the sternomastoid muscle.

These may be shelled out without attempting to remove the capsule, the operation being much simpler than with the tuberculously infiltrated nodes, but secondary operations are not infrequently required. Constitutional and hygienic treatment before and after operation are essential.

MALIGNANT LYMPHADENOMA; HODGKIN'S DISEASE; PSEUDOLEUKEMIA.

The glands in the neck in common with those of other portions of the body become enlarged in a GENERAL LYMPHADENOMATOSIS. The onset is usually in the glands of the neck, extending to axilla, groins and mesentery. These swellings do not fuse as in sarcoma, nor suppurate. The disease is rare in children but is progressive, ending in exhaustion and death.

The diagnosis of malignant from simple lymphoma is difficult or impossible in the early stages.

Surgical interference is only indicated when pressure upon the larynx justifies tracheotomy.

The therapeutic and persistent effect of the X-ray offers delay if not cure of the malady.

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[1] Willard, Ligation Internal Jugular, Univ. Med. Mag., Phil., Dec., 1891, 224.

LYMPHOSARCOMA.

Primary sarcoma of the neck is rare in children. The tumor is movable, semisolid and does not tend to suppurate. Its growth is very rapid, differing thus from congenital hygroma.

An early and free removal is demanded as soon as diagnosis is established. Excision of the internal jugular vein or carotid artery may be required. Complete removal of the growth is the only possible escape from death.

TORTICOLLIS.

Synonyms: Wryneck; caput obstipum; collum tortum or distortum; Schiefhals; cou tortu.

Wryneck may be CONGENITAL, ACQUIRED, or SPASMODIC.[1] The former cases, though called congenital, are usually due to obstetrical injury from severe traction or from pressure of forceps on the neck muscles and nerves. Cases appearing before ten may be due to this same cause. The sternomastoid is the muscle most commonly involved. A congenital malformation of vertebræ occasionally exists.

FIG. 48.—Wryneck from contraction of the right sternomastoid with rotation of the chin to the opposite side. Cured later by open myotomy of both sternal and clavicular portions of the muscle, with subsequent muscular development of the left side.

ACQUIRED CAUSES are direct trauma, cold, rheumatic inflammation, myositis, adenitis, abscess, paralysis, cicatrices, cervical spinal caries, cervical rib, ocular defects, etc. The acquired form may follow mumps, scarlet fever, measles, diphtheria, or earache.

In the SPASMODIC variety, while the trapezius and sternomastoid are most frequently involved, yet other muscles than those supplied by the spinal accessory are often implicated and the real disease may be in the gray matter of the cord or the medulla of the brain or in the nerves of the cervical plexus. Spasmodic torticollis is characterized by tonic or clonic contractions. The head is turned permanently or intermittently to one side with jerkings or twistings. In many cases it is an indication of central disease, but may be due to nasal or pharyngeal irritation. The splenius as well as the straight and oblique and the rotary muscles of the atlas may be affected. In addition to the spinal accessory there may be involvement of the posterior primary divisions of the second, third, and fourth cervical nerves, also of the lesser occipital nerve. This variety is much more serious than the other

[1] Willard, Wryneck, Trans. Phila. Acad. Surg., iii, 116; Ann. Surg., xxxiii, 793.

forms, in fact it is sometimes one of the most intractable of diseases, resisting all forms of treatment.

Symptoms.—When the sternocleidomastoid alone is affected, the pull of the muscles upon the mastoid process will incline the head toward the corresponding shoulder, while the chin and face of the patient will be rotated toward the opposite shoulder (Fig. 48); the muscle will stand out prominently as a strong cord (Fig. 49). In cases of long standing the cervical spine will become convex upon the opposite side and COMPENSATORY LATERAL CURVATURE will be produced, with a ROUND SHOULDER upon the convex side. Frequently asymmetry of the face and even of the head will be noted, and in rickety cases, the clavicle may become deformed. In the cases of nerve origin the inclination of the head may be constant or painfully spasmodic. The levator anguli scapulæ is often contracted, lifting and tilting the scapula forward. In congenital cases HEMATOMA of the sternomastoid is evidenced by a hardened mass in the substance of the muscle. Like other hematomata this mass is usually absorbed, but may persist and cause permanent contraction. Congenital cases also are due to intra-uterine nervous irritation.

FIG. 49.—Contracted left sternomastoid muscle; later cured by subcutaneous left myotomy and muscle development of right side.

An excess of fibrous tissue in the place of muscular fibres is a condition found in cases of acquired wryneck; in the cases of nervous origin there is no actual condensation of fibres.

Diagnosis.—The chief diseases to be confounded with torticollis will be TUBERCULOUS CERVICAL SPINAL CARIES, LATERAL CURVATURE, DISLOCATION OF CERVICAL VERTEBRÆ, and ADENITIS. In wryneck the sternomastoid will stand out prominently and the chin will be turned to the opposite side. The movements of the head are restricted in one direction, while in SPINAL CARIES all movements are limited. In spasmodic torticollis the nerve symptoms are irregular and the contractions will differ from the permanent rigidity in all directions and the reflex spasm of spinal caries. In the nervous cases the question of HYSTERICAL CONTRACTION is the only one liable to be confounded with the actual disease. ADENITIS is accompanied by tenderness and acute symptoms. LATERAL CURVATURE may be either the result or the cause of a wryneck. A careful examination of the bared spine and neck will be necessary (p. 256). The author has seen a number of cases of unrecognized DISLOCATIONS of the cervical vertebræ (Fig. 50), the accident having evidently occurred in infancy (Lateral Curvature, p. 258). In one case the accident was caused by the blow of an angry mother (Fig. 51).

Prognosis.—Cases of simple wryneck are usually readily cured by operation provided subsequent muscular training is practised. The spasmodic cases are exceedingly stubborn and often persist in spite of all forms of treatment.

Treatment.—Slight cases of congenital torticollis may be overcome by gentle manipulation, stretching of the contracted tissues, and oil massage of the muscles.

Hematoma of the sternomastoid should be treated by gentle massage with iodine petrogen or by mild electricity.

The treatment of all inflammatory forms of torticollis will of course vary with the disease. In suppurative and tuberculous adenitis the glands should be removed. The abscesses following scarlet fever, or measles, should be opened and drained and gentle subsequent manipulation of the neck enforced. Temporary cases of wryneck occurring from cold or from rheumatism of the muscles, are treated by hot applications and dry cupping, cotton wadding and a stiff starched bandage of the neck. In more persistent cases a leather or wire or felt or plaster collarette is employed.

FIG. 50.—Wryneck caused by early injury of the vertebræ.

Massage, electricity, hot air, stretchings, gymnastics, injections of atropia or of strychnia and other substances are of value. Ointments of belladonna, menthol, chloral, camphor, or morphia are useful. General hygienic measures are essential.

Operative Measures.—Operative measures include FORCIBLE STRETCHINGS, TENOTOMY AND MYOTOMY, subcutaneous or open, and RESECTION OF MUSCLES AND NERVES.

FORCIBLE CORRECTION — REDRESSEMENT. — Under ether, forcible stretchings of the contracted muscles, followed by fixation with gypsum bandage in an over-corrected position will relieve moderate deformities.

TENOTOMY AND MYOTOMY OF THE STERNOMASTOID.—The required amount of division of the contracted muscle will depend upon the amount of contraction and the age of the individual. If the sternal portion of the

muscle alone is involved, the operation is a simple one; usually, however, the clavicular portion will require division and also in old cases, the mastoid insertion. The skin is drawn upward before making the incision so that the scar will be concealed in the shadow below the clavicle. As the structures just beneath the clavicle — the innominate, the carotids and the subclavian — are of such serious import, and as the pleura even has been pierced with fatal results, it is wiser to do an open operation, especially in boys. In girls, also, open incision is necessary when the contraction is severe. Each contracted tissue is separately raised upon a grooved director before division. In slight cases, subcutaneous tenotomy may be performed. The mastoid origin of the muscle sometimes also requires subcutaneous division.

Fig. 51.—Wryneck from injury of cervical vertebræ.

After section, forcible traction upon the head is made to stretch the contracted fascia and other tissues and the head is strongly over-corrected. The most effective and the most comfortable dressing, on account of relief from all pain, is a plaster-of-Paris body, shoulder and head casing (Fig. 52). Another simple dressing is to apply either a child's body-waist or a belt of plaster of Paris to the chest; a head-piece, either of plaster of Paris or of muslin and adhesive plaster, is then attached to this band by elastic straps passing from the mastoid region, one strap behind, the other in front of the shoulder. If the operation and dressing have been aseptic, the head should be held in an over-corrected position for two weeks, after which the stitches are removed and the cast taken off daily for voluntary and involuntary movements. The operation should be followed by many weeks of massage and gymnastic exercises applied to the muscles of the opposite side of the neck. A head-piece or bridle connected with a rope to a Whitely exerciser or chest weight makes an excellent apparatus to assist voluntary and involuntary motions. The appliances in a special orthopaedic gymnasium are also useful (p. 235). Traction upon the neck and self-suspension are often of advantage. These exercises

Fig. 52.—Plaster-of-Paris dressing.

are far better than uncomfortable and practically useless braces. Relapse must be prevented by constant manipulations and exercises for months.

The cases of SPASMODIC type are persistent and much more serious, especially if there is central disease or irritation. They are extremely

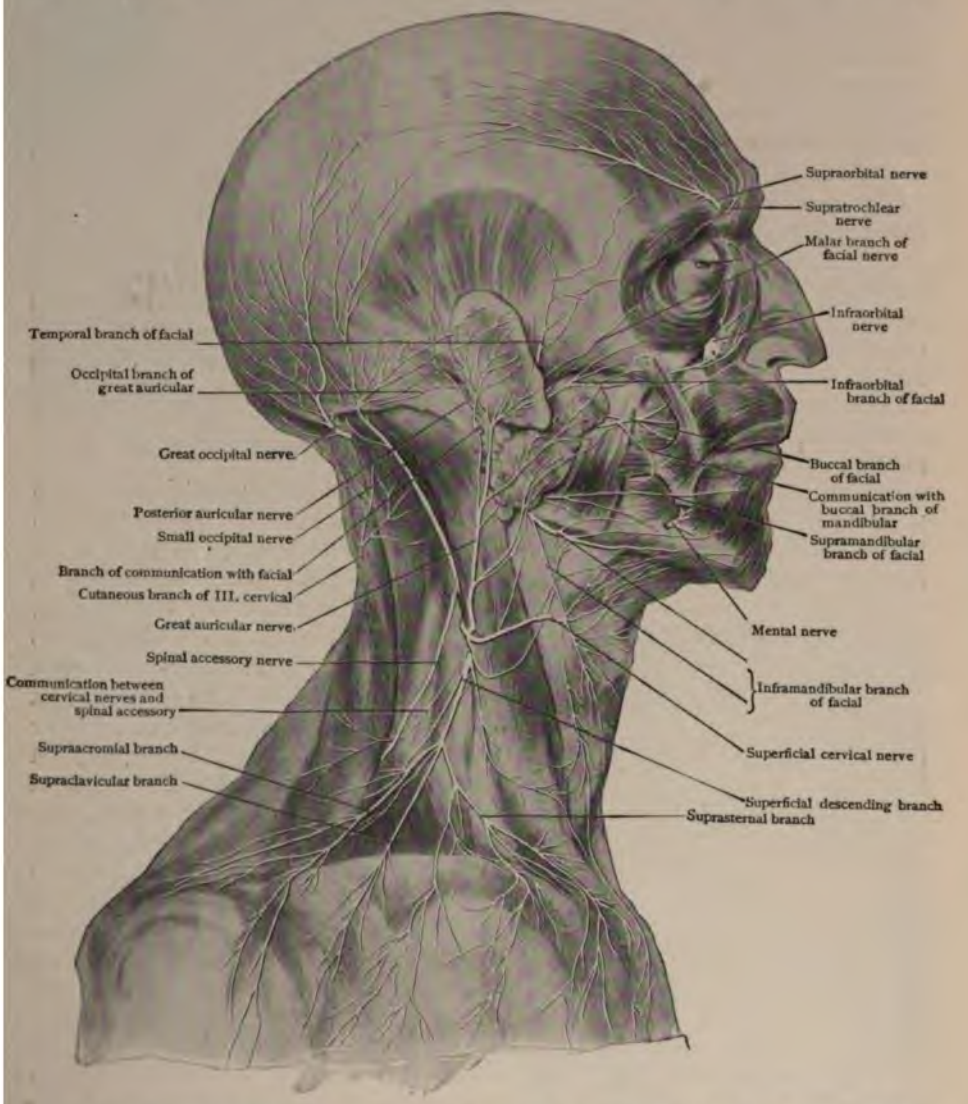

FIG. 53.—Dissection showing superficial branches of cervical plexus, as well as parts of trigeminal, facial spinal accessory and great occipital nerves; ear has been drawn forward. (Piersol's Anatomy.)

likely to return even after repeated operations. The muscles most frequently affected are the sternomastoid, trapezius, splenius, the scalenes and the oblique muscles of the atlas. It is, of course, important to discover the cause if possible, and relieve it by medicinal and hygienic means. Almost

every drug has been used with uncertain results. Muscular training in an orthopaedic gymnasium, travel, and out-door life (p. 380) are all essential. Deep muscular hypodermics of strychnia, atropia, or chloroform are helpful. Massage and regulated voluntary movements of the head and neck are necessary.

Serious spasmodic wryneck will continue to relapse even after division of the sternomastoid, trapezius, and scalene, in fact, of all contracted muscles. RESECTION OF THE SPINAL ACCESSORY (Fig. 53) and, secondly, RESECTION AND AVULSION OF THE SECOND, THIRD, AND FOURTH cervical nerves (Fig. 54) have often failed to cure.[1] STRETCHING of the SPINAL

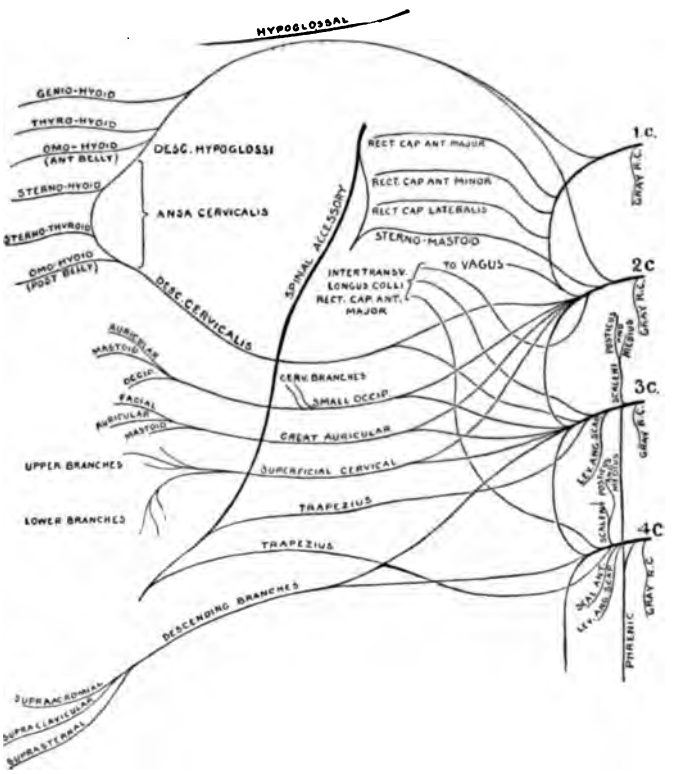

FIG. 54.—Diagram illustrating plan of cervical plexus. (Piersol's Anatomy.)

ACCESSORY (neurectasis) has never proved of much benefit, and complete EXCISION of the sternomastoid with the spinal accessory nerve may even fail to control the spasmodic movements in the severe cases.

PARALYTIC WRYNECK.—The author has seen one case only of complete paralysis of the posterior muscles following diphtheria, in which the chin lay continually upon the sternum of the patient, the head being raised only by the hands. The patient had to be fed in the recumbent position. Treatment was unavailing. He has also under care at the present

[1] Keen, Bull and others have reported successful cases, Ann. of Surg., Jan., 1891; Keen's Surgery, iii, 290.

time a child two years of age in which there is apparent total loss of power in all the posterior cervical muscles, following an exhaustive disease.

WRYNECK FROM DEFECTIVE VISION is usually caused by the carrying of the head in the position best favoring good vision, especially in hypermetropic astigmatism, or inequality of vision, or difference of the planes of sight.

MECHANICAL APPLIANCES.—Complicated wryneck braces are annoying and useless, unless preceded by operative measures and even then are seldom helpful. As a part of the preliminary training of a child for operation, however, a simple laced leather band, or a plaster-of-Paris cincture may be placed around the head and connected by a rubber band from the mastoid region to a waist or corset or wide plaster band about the thorax.

CONGENITAL CERVICAL FISTULA; PATENT THYROGLOSSAL AND BRANCHIAL DUCT.

CONGENITAL MEDIAN CERVICAL FISTULA is the result of a persistent thyroid or thyroglossal duct, a retention cyst, with a permanent or intermittent glairy discharge, or it is due to an incompletely closed branchial cleft. A midline tumor appearing at any time during childhood should lead to a suspicion of this defect. PERSISTENT BRANCHIAL FISTULA and CYST arise from imperfect closure of the embryonic branchial clefts. The openings are usually along the anterior border of the sternomastoid. PATENT THYROGLOSSAL DUCTS have a different fetal origin, since embryologically they originate in a developmental error of the thyroid gland. These sinuses may lead to the hyoid, to the thyroid, to the tongue, or even to the ear. As the thyroglossal duct is an offshoot from the pharynx, an internal opening into this tube may permit the exit of food. Sometimes the inner opening of the fistula is closed, the discharge of mucus or pus appearing on the skin; in other cases the opening is within, being lined with either mucous or skin epithelium.

Treatment.—The ramifications of a fistula are best determined by injecting with bismuth subnitrate 30 parts to melted vaseline 60 parts, and then employing the X-ray shadowgram. By injecting with methyl blue, inserting a probe as guide, laying off a flap of skin and completely excising the track to the hyoid or thyroid, the author has succeeded in permanently closing these fistulæ without much disfigurement. A subcuticular stitch is inserted. If any drainage is needed, horsehair or catgut can be used for a couple of days. Complete dissection up to pharynx or tonsils may sometimes be required. If the skin opening and connective tissue are first freed around the orifice, the duct may be straightened and followed with a probe to its internal orifice.[1]

PHARYNGEAL DIVERTICULA are also the results of defective formation.

CERVICAL AURICLES consisting of yellow elastic cartilage and muscle fibre are occasionally connected with a cervical fistula arising from the branchial clefts.

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[1] Surg., Gyn. and Obstet., May, 1907; Jour. Amer. Med. Assoc., Dec. 16, 1905, 1856.

LYMPHATIC CYSTS are congenital, are usually found in the antero-lateral aspect of the neck, and are known as HYDROCELES of the NECK.

A long and branched lateral branchial fistula is often so intimately associated with the nerves, arteries, and veins that safe dissection is impossible. By injecting with bismuth or with methyl blue, however, excision may be cautiously attempted by a skilful surgeon.

Injection with tincture of iodine or with bismuth and vaseline will occasionally secure closure of the fistula, if it has no internal opening. A median fistula, called tracheal fistula, leads to the trachea, but does not necessarily communicate with it.

HYGROMA.

Synonyms: Congenital cystic lymphangioma; hydrocele of neck; congenital lymphangiectasis.

Dilated lymph-spaces in the neck may exist at birth, or enlarge subsequently. They may be small in size or occupy the entire lateral cervical region. They may be multilocular or consist of a single cyst. When of rapid growth, they sometimes cause death by suffocation unless punctured. Another form of hygroma, to which the name of HYDROCELE OF THE NECK (Fig. 55) is given, is due to the non-obliteration of a deep branchial cleft, which gradually becomes distended with degenerated epithelium and the secretion of the included or occluded epiblast. These cysts may send offshoots toward the tongue or axilla. Occasionally association with nevoid tissue renders diagnosis difficult. A dermoid cyst-hydrocele extends deeply into the cervical tissues.

FIG. 55.—Congenital hygroma of neck. Removed by dissection.

Treatment.—As these cystic lymphangioma sometimes become obliterated spontaneously or by inflammatory action, Owen advises repeated tappings rather than excision,[1] since the dissection may be extensive and dangerous. Simple cysts, resisting tapping, should be excised, or injected with Lugol's solution of iodine, or incised and drained.

STATUS LYMPHATICUS; LYMPHATISM; THYMIC TRACHEOSTENOSIS.

A hyperplasia of the lymph-nodes, especially of those in the tracheal region, with enlargement of the thymus gland and of the spleen, is recognized as a variety of lymphatism.

[1] Owen, Surg. Dis. Chil., 1897, 131.

t with such a condition may present no symptoms of disease, nesthesia or some trifling operation, sudden death may take her cases dyspnea or convulsions occur early without assign- The thymus may be enlarged below the sternum and produce he trachea or on the laryngeal nerves. If the condition is nesthesia should be avoided. It occurs chiefly in infants ar of age but may manifest itself later. This condition is one requent causes of sudden death in infants and it undoubtedly fluence in determining a fatal issue in bronchopneumonia, or n, or in a surgical operation. The diagnosis is so uncertain h intubation and tracheotomy have been performed for the , no relief has followed. The sudden dyspnea may be due to c thymus gland compressing the trachea, although but little to its true nature. Tracheoscopy and the X-ray may aid in .

nt.—If the dyspnea is urgent, TRACHEOTOMY is indicated. In es THYMECTOMY may be performed.

FOREIGN BODIES IN THE AIR-PASSAGES.

are liable, in play, in laughing or crying, or during sleep, to eir air-passages a variety of foreign bodies, such as buttons, s, pins, corks, seeds, fruit-stones, or food.[1] With creeping istory is obtainable. The violent inspirations of whooping- oductive of this accident, will mask the symptoms. Any the region is promptly followed by violent cough, which e object, or it may lodge in the larynx or trachea, or pass he right bronchus, the opening of which is in more direct trachea than the left. A small object may pass into the odivisions.

ns.—If the object is not immediately expelled, the symptoms d loss of voice become most violent and alarming, threatening ation and demanding prompt measures of relief. The severity oms will depend upon the size, shape and character of the sub- ns and soft objects will enlarge by absorption of moisture but isintegrate. Hard objects, long retained, may produce ulcera- uration or lung abscess. One of the author's cases was fatal on of a chestnut shell in a secondary bronchus. Nails and en retained in the lung for months, sometimes unrecognized, larming symptoms resembling tuberculosis. The vomit of od in surgical anesthesia, and especially fecal vomit entering s so productive of septic pneumonia and death that prelimi- f the stomach is advisable. An impacted bronchus, shutting om all or a portion of a lung will give the physical signs of mplete lung collapse, with absence of vesicular murmur, of s and of resonance, together with the presence of dulness. ite side the respiratory sounds will be increased. Bronchial

[1] Poulet, Foreign Bodies, vol. ii, 225.

impaction gives the symptoms of pain in the chest, dyspnea, lividity and cough, with less interference with the voice than in tracheal impaction, but the prognosis is far worse. The body may shift from the right to the left bronchus. In partial obstruction, a portion of lung may be resonant.[1] Pneumonic consolidation may speedily follow, or lung abscess result with a fatal termination or possibly with a final expulsion of the object.

Diagnosis.—Careful and methodical laryngoscopic and bronchoscopic examination, with auscultation and percussion should be employed in all cases of supposed foreign body impaction, provided the symptoms are not urgent. With metallic objects if time permits, X-ray shadowgrams taken at several different angles, the fluoroscope, or the telephone probe, will give much information as to location and size. It is important, in young children to ascertain the character of the object and also the fact that it has not been swallowed or expelled by the initial cough. The author once witnessed a fatal tracheotomy by a noted surgeon, for a foreign body which was later found in the child's pocket. A preliminary examination of the chest would have informed him that the dyspnea was due to a double pneumonia.

Treatment.—Immediate succussion of the body and the promotion of coughing will often dislodge the mass. Inversion of the child is sometimes dangerous, as the foreign body may fall into the chink of the larynx, still, it is the quickest and best of the immediate domestic remedies, followed by the prone head-down position until the arrival of the surgeon. While expirations should be encouraged, inspirations should be controlled lest the foreign body be carried deeper into the air-passages. Foreign bodies lodged above the cricoid cartilage can usually be discovered by good illumination and the laryngoscope and can be removed by forceps through the mouth and pharynx.

If tightly caught in the ventricle or in the vocal cords, laryngotomy or thyrocricotomy will be necessary for extraction. The cricothyroid membrane is superficial and thin and is easily reached. As these operations are very similar to the more common one of tracheotomy, the general directions given on page 89 will be sufficient guide for their performance. If the larynx is split, care must be taken to keep directly in the median line to avoid injury of the arytenoid muscles and cartilages. A cricotracheotomy is advisable if the position of the obstruction is in doubt, since exploration can then be made through the wound both upward into the larynx and downward into the trachea. The tracheal wound can be enlarged downward if necessary. The trachea may be opened above at the site of or below the thyroid isthmus, according to the location of the obstruction. If the impaction is in the bronchus, the opening should be as low as possible, using every precaution not to injure the vessels lying just above the sternum. Chloroform is the safest anesthetic for infants; in older cases local anesthesia will be sufficient. A fluoroscope used at the time of operation will assist in locating and seizing the object. The slit in the rings of the trachea should be an inch or more in length and, if the object is large or irregular in shape, a circular button may be excised. The borders of the slit are

[1] Stengel, Univ. Med. Mag., 1891, 729.

grasped before opening, with two pairs of tenaculum forceps or with two inserted silk loops in order that the orifice may be immediately stretched open to permit escape of the foreign body and not allow it to become impacted above in the larynx. The violent cough that will be excited by the entrance of air will frequently expel the object and a towel should be held so that it is not lost or does not escape notice. Should the object still remain, curved forceps with tiny teeth or flexible forceps are introduced and the object carefully sought. Beads and hard bodies are difficult to grasp even when recognized. Beans and soft objects are not distinguishable from the cartilaginous bifurcation of the trachea. Illumination and bron-

FIG. 56.—Bronchoscopy and extraction of foreign body by spring forceps. (Schantz.)

choscopy [1] may disclose the position (Fig. 56), but it must always be remembered that prolonged manipulations and search beyond a few minutes are more fatal in results than leaving the object to the expulsive efforts of nature through the tracheal opening. The risks of septic pneumonia are greatly increased by the prolonged or vigorous extractive efforts with traumatism of the bronchi. Subsequent voluntary expulsion of soft objects has occurred in 75 per cent. of cases. A large-sized soft rubber tube nearly filling the trachea, connected with a bulb syringe, or Bier's suction apparatus (Fig. 332, p. 389), or an aspirator or Bigelow litholapaxy evacuator (Fig. 133, p. 196) may succeed in loosening the body. In case

[1] Jour. Amer. Med. Assoc., Sept. 25, 1909, 1009.

of tacks or nails, a small round electro-magnet or an electrical probe may assist in locating and removing them. Wire curettes, scoops, and hooks, are occasionally useful but are dangerous.

Killian [1] and others have succeeded by low bronchoscopy and forceps in reaching even the third bronchial division.

AFTER TREATMENT.—If the foreign body has been secured,[2] the wound in the trachea may be closed and aseptic dressings applied. If still retained, the wound should be kept wide open with the silk loop traction sutures tied behind the neck, or by stitching the edges to the skin, or with a large sized soft rubber tube. The child's hands must be thoroughly restrained and a thin gauze veil kept loosely over the opening to prevent unrecognized escape of the object during coughing. The temperature of the room should be kept above 80 degrees and perfect quiet enforced.[3]

Bronchotomy through the Chest Wall.—If removal through the trachea fails, the surgeon has before him one of the most difficult problems in surgery. The question of whether to further pursue operative measures by bronchotomy through the chest walls, or to leave the object to the expulsive efforts of nature, is a most serious one. To open a bronchus through the chest walls and successfully extract a foreign body involves a series of manipulations, perils, and difficulties that will tax to the utmost his skill, coolness, and judgment (Fig. 57).

BOTH ANTERIOR and POSTERIOR THORACOTOMIES have been attempted, and, while these operations on the cadaver are entirely feasible, yet in the living subject the conditions are entirely different. The author at autopsy has seen the bronchus of a dog apparently within easy reach, which same bronchus he had seen ten minutes previously, surrounded by huge swelling pulmonary and azygos veins, with aorta, pneumogastric, root of lung and every structure in the neighborhood making such violent and wide excursions in the frightful struggles of air hunger in lung collapse, that accurate manipulations were impossible.[4] With oxygen, artificial respiration apparatus, forcible insufflation through an intralaryngeal tube, Matas',[5] Bloom's or Doyen's modifications, or by operating within a vacuum cabinet [6] the chances for success are greatly increased.[7] The Fell-O'Dwyer artificial respiration apparatus is helpful (Fig. 58). Tiegel's apparatus[8] consists of a small mask, a rubber balloon, a tank of oxygen or compressed air and a water jar.

COLLAPSE OF LUNG.—In the absence of any cabinet or definite pressure apparatus, collapse of lung from pneumothorax may be met by closing the mouth and one nostril of the patient and passing the tube from an oxy-

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[1] Killian, Berl. klin. Woch., 1895, No. 2; Guysez, Presse Méd., Dec., 1903; Schroetter, Münch. med. Woch., 1905, 26.

[2] Weist, Bronchotomy, Trans. Amer. Surg. Assoc., 1883, 121.

[3] Willard, Jour. Amer. Med. Assoc., Oct. 26, 1901; xxxvii, 1077.

[4] Willard, Tr. Phil. Coll. Phys., 1891, xiii, 133; Univ. Med. Mag., Feb., 1892, 333; Bronchotomy through the Chest Walls, Tr. Amer. Surg. Assoc., 1891, ix, 345; Amer. Jour. Med. Sci., Dec., 1891, 566.

[5] Matas, Annals of Surgery, 1899, xxix, 409.

[6] Trans. Surg. Sec. Amer. Med. Assoc., 1908; Crile, Surg. Resp. System, 1896.

[7] Northrop, N. Y. Presby. Hos. Rep., 1896.

[8] Jour. Amer. Med. Assoc., July 4, 1908, 87; Zentralbl. f. Chir., Leipsic, May 30, 1908.

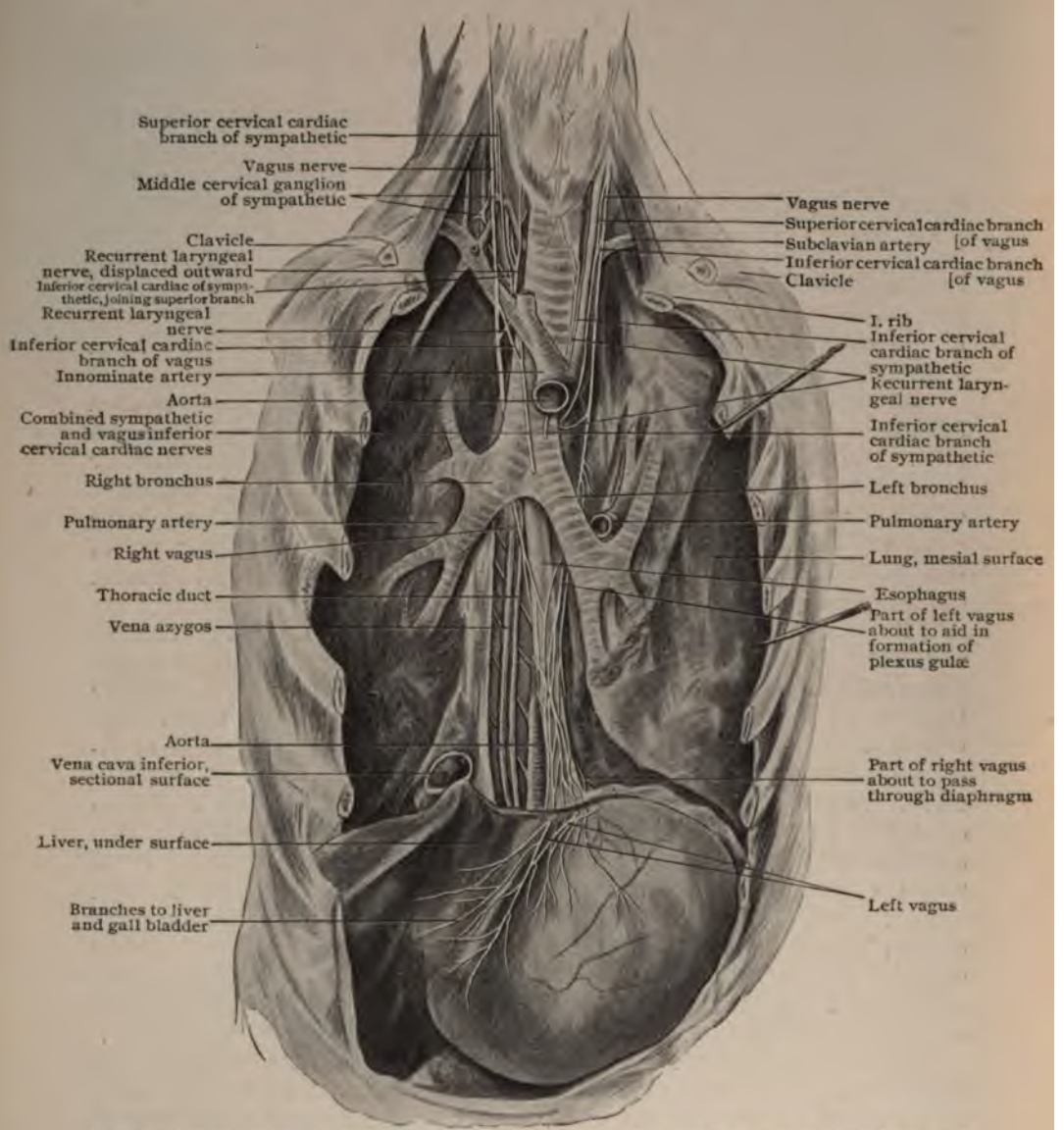

FIG. 57.—Dissection showing lower part of pneumogastric nerves and their branches with their relations to the bronchi. (Piersol's Anatomy.)

gen bag into the other nostril, the pressure sometimes being sufficient to expand the lung and force the air out from the pleural cavity.[1]

Special appliances are not likely to be at hand in an emergency and are only available for a secondary attempt.[2]

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[1] Intratracheal forcible insufflation was employed as early as the War of the Revolution.

[2] Willard, Removal of Foreign Bodies in the Air-Passages, Jour. Amer. Med. Assoc., Oct. 26, 1901; xxxvii, 1077; Trans. Surg. Sec. Amer. Med. Assoc., 1901, 423.

Anterior Thoracotomy.—The anterior route (Fig. 59) has been attempted by splitting the sternum,[1] or by an anterior rib flap,[2] or by removal of ribs.[3] Even after successful extraction of the body from the bronchus, stitching of the slit, and closure of the external wound, the author has found, as a serious after-complication, a constantly increasing pneumothorax.[4] This occurs from the cylindrical shape of the bronchus allowing escape of the air into the pleural cavity but preventing its return from the pleura into the bronchus. The suturing of the bronchus by the method proposed by Willy Meyer will largely avoid this accident.[5] The danger of fatal pneumothorax and collapse of the lung may be lessened by the employment of the vacuum cabinet of Sauerbruch,[6] which produces negative pressure on the lung. This cabinet can, however, be employed for positive pressure by placing the patient's head inside the box. Brauer's apparatus employs positive pressure, and Robinson, Green, Maury, and Willy Meyer[7] have simplified and improved the technic.[8]

Fig. 58.—Fell-O'Dwyer artificial respiration apparatus: intralaryngeal tube with air-bellows worked by foot.

Posterior Thoracotomy.—The posterior route through the mediastinum opposite the fourth to the seventh ribs is the more hopeful one, as the operation is more easily and quickly performed. Curtis was successful in reaching the bronchus and opening it, but unsuccessful in removing the object or in saving the patient. Bryant,[9] Curtis,[10] Fowler,[11] and others have so minutely described the technic of the operation that it need not be inserted here.

[1] Friedrich, Jour. Amer. Med. Assoc., Dec. 11, 1909, 1970; Lancet, London, Mar. 27, 1897; Bryant, Oper. Surg., ii, 1052.
[2] Gaston, Trans. Amer. Surg. Assoc., 1896, 465.
[3] Rushmore, N. Y. Med. Jour., July 25, 1891, 85.
[4] Willard, Bronchotomy through the Chest Walls, Tr. Amer. Surg. Assoc., 1891, ix, 345.
[5] Jour. Amer. Med. Assoc., Dec. 11, 1909, 1978.
[6] Trans. Surg. Sec. Amer. Med. Assoc., 1908, 332.
[7] Jour. Amer. Med. Assoc., Dec. 11, 1909, 1984.
[8] Jour. Amer. Med. Assoc., 1908, 345, 351, 359.
[9] Bryant, Operative Surgery, ii, 1046; Trans. Amer. Surg. Assoc. 1895, 443.
[10] Curtis, Annals of Surgery, 1898, 605.
[11] Fowler, Treatise on Surg., i, 596.

PNEUMOTOMY.—In blockade of a portion of the lung the patient may survive and the foreign body be coughed out months later, or ulceration, purulent discharge and symptoms of lung destruction follow, or the object may ulcerate its way into the aorta, esophagus, or mediastinum. Again, it may work toward the pleura either before or after pleural adhesions have occurred. The author has found both by experiment on dogs and by operation in the living human subject that the lung may be safely reached by the resection of ribs and the walling off of the pleural cavity, by suturing the two surfaces in the form of a parallelogram and then incising the lung with knife or cautery.[1]

FIG. 59.—Relations of bronchial tree to anterior thoracic wall, as shown by X-rays (after Blake). Note straight position of right bronchus as compared with trachea. (Piersol's Anatomy.)

ABSCESS IN THE LUNG, following long impaction of foreign bodies, or from pneumonia, may be reached by first testing with an aspirator, after which, using the canula as a guide, a free incision is made, a section of rib excised subperiosteally and evacuation of the abscess secured by knife or cautery, provided adhesions are found. If pleural surfaces are not united, the membrane may be sutured (pneumorrhaphy) at the borders of the wound by chromicized gut. The wound is then packed with gauze for two or three days. The incision and drainage are made under local anesthesia. Irrigation, exploration and transpleural examination add to the risks of the operation.

Prognosis.—If only moderate signs of interference with respiration are present after the entrance of a foreign body, delay is advisable, since the object may be coughed up.[2]

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[1] Willard, Pneumonotomy and Pneumonectomy, Suturing of Lung, Trans. Phil. Coll. Phys., Nov. 4, 1891, xiii, 133; Univ. Med. Mag., Feb., 1892, 333; Jour. Amer. Med. Assoc., 1893, xxi, 295; also, Sailer and Patek, Univ. Med. Mag., May, 1891.

[2] Penna. State Med. Jour., May and June, 1907.

Smith gives sixteen hundred cases with 70 per cent. recoveries in non-operative cases. The general mortality will be about 33 per cent. Formerly all cases of impaction in the bronchi were fatal, but with bronchoscopy even the third division of the bronchus has been reached and the foreign body removed (p. 79).

Low tracheotomy should be performed for bodies fixed in the trachea, as it adds but little to the risks and affords safer exit for the object either by immediate extraction or by subsequent voluntary efforts. When a foreign body becomes impacted in the bronchus, extraction is possible with tracheotomy in 25 per cent. of the cases. Since subsequent voluntary expulsion through the tracheal opening is quite probable, instrumentation through the trachea should never be prolonged beyond a few minutes, since pneumonia is greatly increased by manipulations; 30 per cent. die of this disease after unwise instrumentation against 18 per cent. in non-operative cases. Only 10 per cent. die speedily from the operation but the mortality in tracheotomy cases is largely due to injury to the bronchus.

The risks of thoracotomy and bronchotomy following unsuccessful tracheotomy are certainly greater than the dangers incurred by permitting the foreign body to remain, but a few operators have successfully removed a foreign body through the anterior chest wall. Impaction of a bronchus is much more serious than when the trachea is obstructed, the chances of removal are much diminished. The mortality of tracheotomized cases will vary from 25 to 30 per cent., bronchial impactions giving, of course, the largest percentage of deaths.

SUMMARY.

1. Coughing and inversion are the immediate remedial measures.
2. If laryngoscopic examination and the X-ray reveal the object, it may be extracted through the mouth.
3. If in the trachea, tracheotomy is advisable.
4. If in a bronchus, low tracheotomy, bronchoscopy and a search of short duration are justifiable, with subsequent tracheal suction.
5. If the search of the bronchus is unsuccessful, the safer plan is to leave the tracheal wound open and wait for expulsion by natural processes.
6. Bronchotomy through the chest walls, even with artificial insufflation or with vacuum cabinet, is a most serious procedure and should be undertaken only by a thoroughly skilled and cool-headed surgeon.

LARYNGEAL OBSTRUCTION.

The larynx and trachea may become obstructed by foreign bodies, by diphtheritic membrane, by edema from scalds or noxious vapors or erysipelas, or by chronic stenosis from syphilis or tuberculosis or tumors.

The operations that may be demanded are LARYNGOTOMY, THYROTOMY, THYROCRICOTOMY, TRACHEOTOMY, and BRONCHOTOMY THROUGH THE CHEST WALLS, the names of which are sufficiently indicative. As the first named do not differ materially from tracheotomy (p. 90) they need

ately described. The term BRONCHOTOMY, formerly applied ion upon any portion of the air-passages, should be restricted ng of a bronchus through the chest walls.

LARYNGEAL DIPHTHERIA.

onyms: Membranous croup; true croup; membranous laryngitis.

al diphtheria beginning in the larynx is rare, the condition wing a pharyngeal or undiscovered nasal infection caused by öffler bacillus. As the cases of streptococcic and staphylo- on associated with the diphtheritic bacillus are very produc- geal invasion, the safest plan of treatment is to consider all branous stenosis of the larynx as diphtheritic until they are wise. In children under two years of age laryngeal involve- n nearly 40 per cent. of the cases.[1] The absence of the Klebs- us in the presence of definite diphtheritic symptoms, should d as a proof of the non-existence of the dread disease. In e of sore throat with fever and exhaustion should be closely viewed with suspicion. It should also be remembered that irds and other house pets, as well as poultry and cows, may f the poison.

s Demanding Intubation or Tracheotomy.—Any one who l the trachea of a child at the post-mortem table will have with its exceedingly small calibre and will not be surprised ckly obstructed by a diphtheritic membrane and submucous The dyspnea will usually be preceded by fever and exhaus- characteristic gray deposit in fauces and nose from which ffler bacillus may be cultured. Enlarged lymph-glands behind possibly toxic albuminuria appear early. A gray patch on e is more diagnostic even than one on the tonsil. If antitoxin n in proportion to the age of the child has been delayed or neffectual, laryngeal and tracheal invasion will be evidenced ncreasing efforts at inspiration and expiration, with recession sternal and supraclavicular and epigastric regions. The flat- lower part of the chest seems to sink the xiphoid cartilage bodies of the vertebræ in the desperate struggle to secure air. should always be bared for examination. The respiratory be absent and cyanosis will be progressive; the voice will be llic, then lost entirely.

s.—The diagnosis from foreign bodies, catarrhal laryngitis, eal abscess and bronchopneumonia will depend largely upon f the case and the existing symptoms. In any case of serious g dyspnea with high temperature and weak pulse, exhaus- s of voice, either intubation or tracheotomy is imperative, d presenting these symptoms will die from want of air.

nt.—ANTITOXIN.—As soon as the diagnosis is made from clin- s and without waiting for the laboratory report diphtheritic

[1] Holt, Diseases of Infancy and Childhood, 1906.

antitoxin should be given in doses of 1000 to 15,000 units every six hours, regulated by the age of the child and the severity of the attack. Statistics show that if the serum treatment is given ON THE FIRST DAY, the mortality is less than 1 per cent., while if given after the FOURTH DAY, the death-rate rises to 25 per cent. or more. The lowest mortality rates for diphtheria are in the cities where reliable antitoxin is systematically and early employed. Doubters as to its efficiency are now fortunately few.

Painting the throat with a 2 per cent. solution of silver nitrate after taking the culture is helpful, as is also the spraying of the nose and throat with peroxide of hydrogen 1: 3; these procedures are only accessories to the early administration of antitoxin, as are also the giving of food and stimulants.

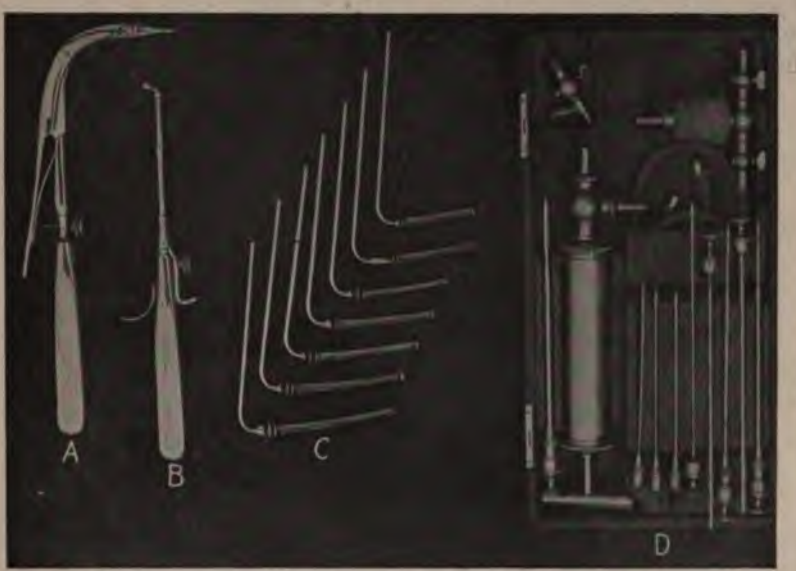

FIG. 60.—Intubation instruments. *A*, extractor; *B*, introducer; *C*, tubes; *D*, aspirator.

Antitoxin having failed, early operation is of extreme importance in diphtheritic obstruction before the child is cyanosed and ladened with carbonic oxide. The danger lies not in the operation but in delay and toxic infection. To wait until the child is so asphyxiated that it is practically moribund is to be condemned. If, as frequently happens to the surgeon, the patient is first seen only when in this condition, an operation is still advisable since only air in the lung can save life. Even when death has followed in a few days from the diphtheritic poison, the author has never regretted (nor have the parents) the use of either intubation or tracheotomy. The marvellous comfort afforded in seeing the child quietly inhaling sufficient air, after the heart-rending but ineffectual struggles before the operation, amply repay both operator and friends. Fortunately, intubation requires less persuasion of parents than tracheotomy and offers earlier relief. Even with the free use of antitoxin before and after operation, the poison of the disease will kill a large percentage of the cases, but it is the toxemia of the disease, not the operation, that destroys. The operation

prolongs life and gives the opportunity for oxygen, food stimulation, and antitoxin to complete the work, when without relief the patient would be dead. An operation commenced should be completed even although breathing has apparently ceased, as artificial respiration and the inhalation of oxygen has sometimes restored patients after life has been apparently extinct.

Intubation (O'Dwyer).—Intubation has now largely superseded tracheotomy for the relief of laryngeal diphtheria, as it is simpler and more speedy, requires no anesthetic, and the consent of parents can be much more readily obtained. It prevents loss of blood and shock and there is less danger of bronchopneumonia. In the after treatment trained care is less essential. Every surgeon should be provided with an intubation set (Fig. 60), since, when needed, the demand is urgent. Newer sets are made of hard rubber lined with gold-plated metal (Fig. 61).

Fig. 61.—Intubation tubes and introducer. (Wharton and Curtis.)

Intubation Technic.—The operator should protect his nose and mouth with antiseptic gauze and his clothing by a sheet or gown. The child's arms, legs, and body should be wrapped tightly in a sheet and held firmly against the nurse's protected breast. A thread well oiled is loosely looped through the eye of the tube, for withdrawal in case it is coughed into the pharynx. All the instruments, sterilized, should be conveniently placed for rapid work. An assistant grasps the head firmly and throwing it slightly backward, holds the mouth-gag securely with his left hand. The introducer is armed with tube selected according to the scale and adapted to the age of the child, 1, 2, 3, 4, corresponding to ages 1, 2, 3, 4. The surgeon introducing his left index finger recognizes in the pharynx the hard projection of the posterior part of the cricoid cartilage. He hooks forward the epiglottis and base of the tongue, feels for the opening of the larynx (Fig. 62), and quickly carries the tube through the mouth and fauces by a curved motion in elevating the handle from the front of the chest to the level of the nose, and with thumb of right hand releases the tube from its obturator while he adjusts it in the larynx with his left finger. The operator must be expert or the finger in the glottis will seriously add to the asphyxia. After the first coughing efforts and being certain that the tube has not been forced into the pharynx, the finger is withdrawn, the gag removed and the respiration watched to see that no membrane has been dislodged

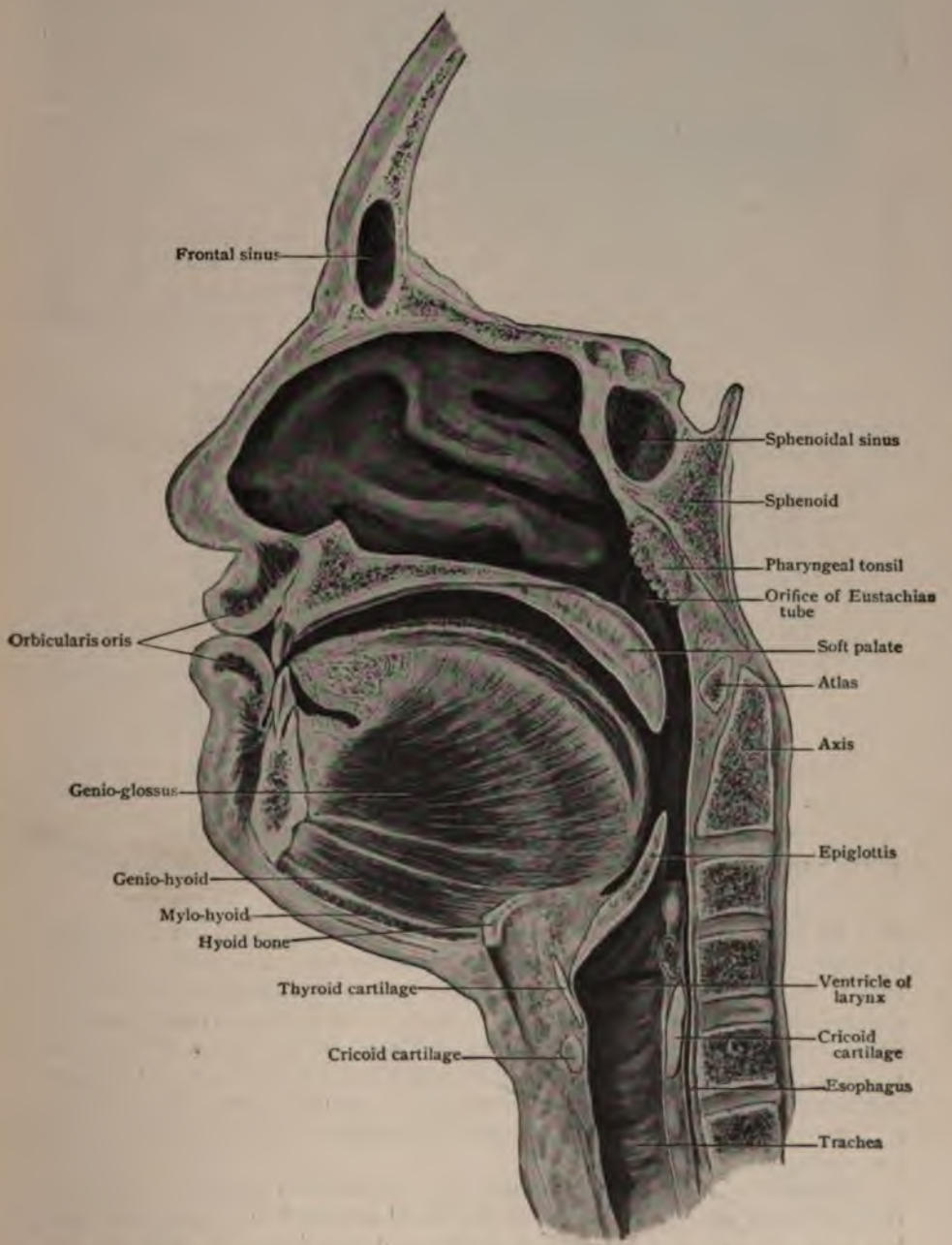

FIG. 62.—Sagittal section of head of young adult, three-fourths natural size, showing relations of larynx to pharynx and esophagus. (Piersol's Anatomy.)

into the trachea. In such an event, the tube should be withdrawn to permit expulsion, or a tracheotomy may be necessary. If breathing remains easier for ten or fifteen minutes, the gag and finger are reintroduced, the position of the tube ascertained and held in place while the looped thread is cut and withdrawn. With inexperienced nursing the thread may be retained and fastened to the cheek, but the child's hands must be restrained.

After Treatment.—An experienced nurse is desirable night and day to anticipate the symptoms of air hunger, but it is not as essential as in tracheotomy. All the precautionary measures given as to tracheotomy (p. 91) should be observed and antitoxin continued, although it is much less effective than in the early stage. Milk may be administered to an infant by lowering the head (Fig. 63), thus preventing its entrance to the tube. The same method may be pursued with older children, or semisolid foods may be given, or if difficulty is encountered, a feeding stomach tube

FIG. 63.—Head-down position for feeding after intubation. (Wharton and Curtis.)

may be introduced into the esophagus through the mouth, or a catheter through the nose. Nutrient enemata are given and also quinine suppositories. Milk punch, wine whey, fresh air heated to 80 degrees and perfect quietude are necessary. If the tube is coughed out, it may lie in the pharynx or be swallowed. Increased dyspnea will lead to the summoning of the surgeon, an examination by the finger and the reintroduction of the tube. In cases of paralysis of the laryngeal muscles and a repetition of the accident, a competent physician should remain constantly in the house for the first few days.

Removal of the tube requires the same preparation as for its introduction and may usually be done on the third or the fifth day if antitoxin has been administered before and after the intubation. The gag is introduced, the extractor (Fig. 64) passed down into the lumen, the blades separated and the tube withdrawn. As the insertion of the extractor into the opening is a difficult maneuver in a struggling child, the manipula-

tions should have been practiced on the cadaver and perfect understanding of the mechanism of the instruments attained without the aid of sight. If the tubes are provided with metal loops at their heads, a finger thimble and hook attachment renders removal easier (Fig. 65).

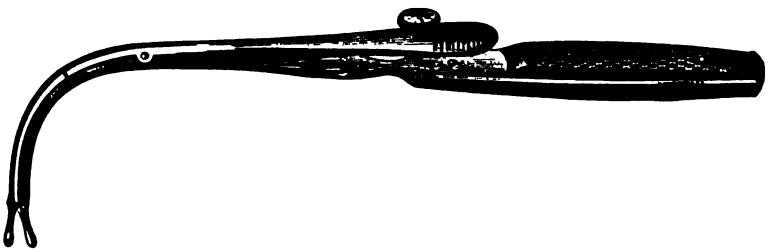

FIG. 64.—Extractor with movable jaws for extraction of intubation tube. (Wharton and Curtis.)

Remarks. — Both introduction and removal must be quickly performed. Tracheotomy instruments should be at hand, as even in the hands of an experienced operator nearly five per cent. will require this form of relief on account of alarming dyspnea produced by membrane that has been loosened and cannot be coughed out. A certain amount of dyspnea may be expected to follow the removal of the tube. If continuous or increasing, the tube should be reintroduced. Persistent difficulty of breathing following the removal of the tube is less common than after tracheotomy. It may be due to spasm or paralysis or thickening. Failure to introduce the tube into the larynx results from inexperience in the recognition of the cricoid prominence in the esophagus, the epiglottis and the opening of the larynx. When the tube is in proper position the anterior wall of the esophagus will be felt between the fingers and the instrument. If it is in the esophagus it will be loose and free and no benefit in breathing will occur. False passages in the larynx will only be made if too great force is employed. The loss of voice following intubation is usually temporary.

FIG. 65. — Finger-hook for extraction of intubation tube.

TRACHEOTOMY.—While tracheotomy has now been largely replaced by the simpler operation it is still required when intubation fails to relieve or when diphtheritic membrane has been pushed downward into the trachea.

The conditions demanding tracheotomy are detailed on page 84. Whenever in doubt, operate.

Technic.—When instant action is necessary, a knife, quill, a catheter or a rubber tube may save a life. The author recalls one of his most successful tracheotomies of former days in the slums, performed with a scalpel in one hand, an oil lamp in the other, and two

on the floor in a faint. When instantaneous work is required, heotomy is safest. The larynx should be grasped with the ought forward and thoroughly fixed in the median position. ury guarded by the middle finger of the right hand so that etrate beyond the desired depth is then thrust into the lower e thyroid cartilage, held vertically and carried downward,

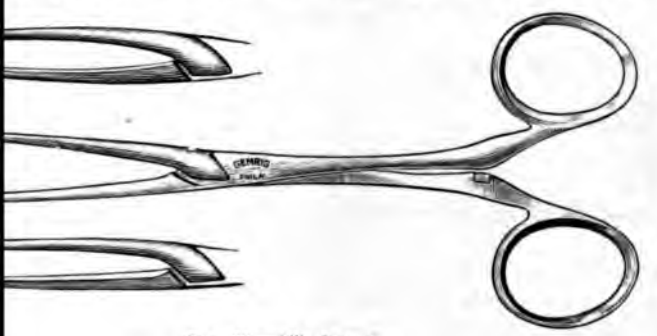

FIG. 66.—Allis forceps.

ricothyroid membrane, cricoid cartilage and two rings of the e edges of the wound are grasped on either side with Allis rceps (Fig. 66) or any form of retractors, everted and tube eps introduced, while hemostatic forceps control hemorrhage. otomy as a rule, the condition of the child is such that but ion is permissible. In extreme cases, the operation may be rapidly required without an anesthetic. Usually, however, chloroform or ethyl chloride may be used, the latter locally. A quick longitudinal cut is made over the trachea. The trachea is made more prominent by a pad placed beneath the shoulders. The thyroid isthmus, which covers the second to fourth tracheal rings, may be retracted or clamped and later ligated. If time permits, hemorrhage should be checked and the rings completely bared from connective tissue, an important point in locating the trachea definitely before entering. The trachea is now firmly fixed by Allis tenaculum forceps or with a strong curved tenaculum and two or three rings slit longitudinally for an inch with a sharp pointed bistoury. The dyspnea is so urgent and the migra-ssues so great that it is safer to make the incision from below oid injury of the structures at the base of the neck. Spring ring nasal speculum, or eyelid retractors, or two tenacula, or tion sutures are now introduced, and the lips of the slit held arger outer tube, aluminum or silver, is then inserted (Fig. ed direction BACKWARD and DOWNWARD, care being taken pushed against the posterior wall of the trachea,[1] nor carried

eotomy
ton and

[1] Willard, Tracheotomy, Med. News, xlv, 726.

down in the connective tissue in front. With a nurse unaccustomed to the reinsertion of the tube in emergencies, permanent retention of the retraction silk loops may prevent sudden asphyxiation. When the air enters freely, the exhausted, cyanosed and nearly dead child will speedily begin to gain in color.

Remarks.—It should be remembered that in young children the normal trachea is an exceedingly small tube;[1] in infants, during the first two years of life not exceeding $\frac{1}{4}\frac{0}{0}$ of an inch, and in the tenth year, only $\frac{1}{4}\frac{6}{0}$, consequently, the canula for a child under four years should not exceed $\frac{9}{4}\frac{}{0}$ nor be above $\frac{1}{4}\frac{3}{0}$ for a child of twelve.

A thorough knowledge of the anatomy of the region is important. The two most common errors in discovering the trachea are first from failing to follow exactly the median line, and second, incomplete exposure of the rings of the trachea. Failure to introduce the tracheotomy tube after the slit is made, is due to carrying it TOO FAR BACK and in too straight a line against the posterior wall, or in missing altogether the slit and tearing up the tissues IN FRONT OF THE TRACHEA, or in failing to puncture through the false membrane by the initial cut. A clear head, steady hand, and dexterous rapidity are needed, especially as dyspnea becomes desperate and threatening when the trachea is exposed and manipulated.

In fat-necked infants the thyroid cartilage may not be palpable in the throes of air hunger. With the trachea not more than an inch or an inch and a half long, and lying deep in the neck, it is safer to enter through the cricothyroid membrane and cut downward into the upper trachea, since the lower portion may be close to the thymus gland, the arteria thyroidea ima and the innominate.

AFTER TREATMENT.—As the air enters directly into the lungs through the trachea, the room should be kept at a high temperature. The author's best results have always been obtained in the summer with the thermometer above 90 degrees. The air should be moistened with steam medicated with limewater or sulphur. The after treatment is of the greatest importance. Almost immediately following the operation, the most delightful change takes place. The cyanosis, noisy stridor, anxious expression, grasping at throat and labored movements of chest disappear as by magic, and the child sinks into a peaceful slumber, abundantly repaying the surgeon for his efforts, even though but temporary relief is gained. Unless the antitoxin conquers the infection, the calm is deceptive. The diphtheritic poison is still present and on the second day renews its force unless counteracted. In many cases, infectious pneumonia follows. Under proper treatment and proper nursing, however, many cases progress favorably. A skilful physician and specially trained nurse should be constantly by the bedside ready to remove the inner tube and cleanse it if any obstruction occurs. The inner tube is to be cleaned and boiled twice daily. The outer tube is best cleaned with a chicken's wing feather wet with limewater. The irritation of the trachea will provoke helpful coughing. OXYGEN also should be constantly in readiness. The orifice of the tube is covered loosely with wet gauze. The mucus as it is coughed up, is caught with a large camel's

[1] Meigs and Pepper, Diseases of Children, 105.

hair brush, moistened in carbolized or sublimated solution. The edges of the wound are painted daily with a five-grain solution of silver nitrate to prevent infection. Atomization of warm limewater also tends to soften the membrane.

After the lapse of five or six days the patency of the larynx can be tested by closing the orifice of the tube with a finger and watching the result. The tube should be removed as early as possible so that the trachea need not become ulcerated, nor a psychic habit of breathing established that may subsequently require an intubation to relieve. The nurse should always have instruments close at hand, since with a child struggling for air no time can be wasted. With an inexperienced nurse, it is wise to leave permanently on either side of the tracheal slit a black silk loop retraction suture, or to cut out a button opening from two to three rings at the time of operation. The child must not be left alone for a moment, as the tube might be coughed out and quick suffocation result.

The occluding membrane should never be sucked from the tube by a too enthusiastic surgeon. A suction cup or a large rubber tube attached to a rubber bulb or suction syringe should be used.

Concentrated food, milk punch, and wine whey are to be given in digestible quantities, or nutrient enemata introduced and antitoxin continued in bad cases. If food is refused, it may be carried into the esophagus by a stomach tube or by a catheter inserted along the floor of the nose. The nose and throat should be sprayed frequently with dilute peroxide of hydrogen.

Prognosis.—The death rate from diphtheria is so high that the mortality from tracheotomy and intubation must necessarily be large, since the operations are performed only on the laryngeal cases. The deaths are from toxemia and not from the operation. The mortality from tracheotomy for laryngeal diphtheria is very difficult to determine, since only a small proportion of operations and a still smaller proportion of fatal results are reported. Fortunately the introduction of intubation by O'Dwyer and the general use of antitoxin has reduced the mortality of the disease itself and tracheotomy is but rarely required. Only twenty years ago some English writers placed the mortality of all cases of membranous croup at 90 per cent. As tracheotomies were of course performed only upon the most serious cases, the death rate from operation was necessarily frightful. The author in 1885 [1] before the introduction of serum therapy, expressed the opinion that not more than 10 to 15 per cent. of tracheotomies could be saved, as nearly all of the cases came to the table when practically beyond hope. Levis operated on twenty cases before he secured a successful result. Owen, before the introduction of intubation, placed the mortality at 60 to 70 per cent. At the present period the operation, even with antitoxin, is exceedingly fatal in infants under two years of age. During the past 15 years since the general introduction of antitoxin the proportion of cases requiring tracheotomy or intubation has been reduced one-half, and the mortality of tracheotomized cases has been also reduced one-half. The general mortality of all cases of diphtheria has also been reduced in the same

[1] Phila. Med. and Surg. Reporter, July 25, 1885.

ratio. Monti collected 12,736 cases of tracheotomy for diphtheria showing 28 per cent. of recoveries, an excellent report, since it is probable that nearly all of these cases would have died if not operated. The death rate in intubated cases has fallen from 70 per cent. before the introduction of antitoxin to 30 per cent. at the present time and tracheotomized cases from 60 to 33 per cent.[1] In 5546 cases of intubation without antitoxin, the mortality was 69 per cent., while in 533 cases in which intubation was combined with antitoxin the mortality was 26 per cent. (McNaughton and Madden). Intubation should give a much better chance for recovery than tracheotomy, since it meets with less opposition and can be performed earlier.

Unfortunately, these cases are often only seen by the surgeon when practically beyond hope. The younger the child, the more fatal the obstruction. Before the days of antitoxin and operative relief, practically all cases of laryngeal diphtheria were doomed. After intubation, if the continuance of antitoxin and stimulants fail, the child dies not from the operation but from the original disease and the too late relief.

HYDROTHORAX AND EMPYEMA.

Pleural Effusions.—Serous effusion into the pleural cavity may follow pleurisy, pleuropneumonia, grippe, trauma, sepsis, tuberculosis, and, rarely in children, malignant disease. In children under five it is often the result of one of the exanthematous diseases. Pneumococcic infection is the most common. In adolescents it may be tuberculous.

Symptoms of Hydrothorax.—The primary symptoms will be those of the original pleuritic disease. In rare instances a large effusion may occur without recognized fever, but with moderate dyspnea dependent upon the amount of lung oppression. The breathing will be short and hurried, especially if the child lies on the sound side. The respiratory murmur will be absent or distant, vocal fremitus and resonance altered or absent, the heart pushed to right or left, and in some instances at the intercostal spaces there will be bulging. The percussion note will be dull or flat and may be altered by position of the body if the fluid is not sacculated.

Symptoms of Empyema.—Purulent accumulation in the pleural cavity is usually preceded by serous effusion, which may be speedily or slowly converted into pus by increase in the number of leucocytes. The constitutional symptoms, rigors, rise of temperature, sweatings, loss of flesh, and prostration will steadily increase.

As the heart is pushed either to right or to left and the lung action interfered with, respiration becomes labored and rapid and the pulse feeble. The diaphragm will be displaced downward and the intercostal spaces become prominent. Following appendicitis, joint infections, or osteomyelitis, the fluid is usually purulent from the time of discovery. In unrecognized or neglected cases, the large fibrinous exudate with thickening of pleura and extensive flocculi of lymph may compress the lung into a small useless mass, converting the whole side of the chest into an enormous pus cavity and destroying the patient. In encysted cases, a pus collec-

[1] Holt, Diseases of Infants and Children, 1906.

tion may be walled off from the rest of the chest or several independent collections may exist with firm septa. In tuberculous pleurisy, the accumulation may be slow and unrecognized. If adhesions exist, they will partially prevent lung collapse.

Diagnosis.—The signs already given differ from those of consolidation following pneumonia, since in the latter disease there will be increased vocal fremitus and bronchial breathing and no fulness of the side. In a child under six, empyema is more probable than hydrothorax. In every case of doubt, an antiseptic puncture, as described below, should be employed. The X-ray will often outline a pus accumulation.

Treatment.—THORACENTESIS — PARACENTESIS — ASPIRATION FOR HYDROTHORAX.—If salines, cathartics, diuretics, and counterirritation fail to relieve, paracentesis is less uncomfortable than blisters and will more quickly relieve the pressure which is preventing the absorbent vessels

FIG. 68.—Hypodermic needle may fail to reach a pleural cavity filled with pus, or it may be blocked by fibrinous deposits. (International Clinics, Hall.)

from removing the fluid. In every doubtful case, puncture with an ASPIRATING NEEDLE should be the rule, not with a hypodermic, since the latter is too small to be diagnostic in its results (Fig. 68). This puncture should never be made without thorough asepsis of site and instruments. In the dorsal position, with side overhanging the edge of the bed and after freezing the area with salt and ice, or ethyl chloride spray, an aspirating needle and canula of medium size should be thrust into the selected spot in an intercostal space just above a rib in order to avoid the intercostal artery. The instrument should be sharp, guarded at a certain depth by the finger and held so that the trocar cannot be driven back in the canula. It is thrust in with a sharp quick stroke, so that thickened membrane will not be pushed before it. A slight incision of skin with a sharp scalpel may be made. A clean aspirator (the working powers of which have been tested just previous to the operation) is then attached, and the fluid slowly withdrawn, care being taken to preserve a specimen, without blood, for laboratory examination. If the lung is expansile, its impact against the end of the canula can usually be felt. If the flow is interrupted, a blunt stylet introduced through the canula will clear the obstruction, or the canula can

be partially withdrawn or the current reversed. If symptoms of syncope or collapse occur, the flow should be temporarily arrested and stimulants administered. Excessive coughing and a flow of blood call for at least a temporary cessation of the flow. These symptoms occur most frequently with dextrocardia.

The slight wound is closed with cotton and collodion or compound tincture of benzoin. If the serum is clear and sterile, absorption of the remaining fluid will usually take place. If reaccumulation occurs, tappings may be continued until turbidity of the fluid and the laboratory examinations show pneumococcic, streptococcic, or staphylococcic cells. If no cocci are present, the case is probably tuberculous.

If the pleural exudate is coagulated by heat, centrifugated and injected into a guinea-pig, the question of tuberculosis of the pleura can be diagnosed. In cytodiagnosis, there may be shown a predominance of mononuclear leucocytes. The agglutination test of Arloing may also be employed. In proteolytic fermentation, the tubercular exudates and pus do not liquefy albumin.

If pus is found at the explorations or at any subsequent tapping, the case should be at once treated as EMPYEMA. If preparations for opening the chest have not been made, the wound may be closed, and a few days allowed for permitting the lung to expand as much as possible provided symptoms are not urgent. In case of extreme distention and with critical symptoms, aspiration of only a portion of the pus is permissible, another aspiration or incision or resection following as speedily as the general condition permits. Spontaneous evacuation into a bronchus or through the chest wall or diaphragm should never be permitted.

The site of the operation will be located by the existing symptoms, and elicited by percussion and auscultation. In encysted cases, the tapping will be made over the diseased area. Ordinarily the puncture is made in the sixth or seventh interspace on a level with the inferior angle of the scapula in the midaxillary line, or posteriorly in the eighth interspace to avoid the excursions of the shoulder-blade. As nearly all cases of hydrothorax show pus-cells at the second tapping, the exclusion of air and thorough asepsis are essential. If an aspirator is not at hand an ordinary trocar and canula may be substituted. An extemporized appliance for excluding air can be made by attaching to an ordinary canula a soft rubber tube long enough to reach to a pan of carbolized solution on the floor. The trocar is pushed through the rubber into the canula, and when withdrawn the opening closes, shutting out the air.

Respirations of 30 to 60 with feeble pulse above 110, a temperature above 101 and a leucocytosis of 30,000 to 50,000, with emaciation, should lead any surgeon to afford speedy, though late relief by evacuation.

INJECTIONS OF FORMALIN.—The repeated injection every three to six days into the pleural cavity of one to four ounces of a 2 per cent. solution of formalin in sterile glycerine, is claimed by Murphy [1] to not only prevent the recurrence of hydrothorax, but even in empyema to obviate the necessity for further operation.

[1] Murphy, Trans. Surg. Sec., Amer. Med. Assoc., 1909; Jour. Amer. Med. Assoc., 1909.

ɴs of Bismuth Paste.—For old chronic cases and also as a the injection of bismuth subnitrate or subcarbonate 1 part seline 2 parts, is proving most satisfactory in the hands of n the effect of this paste on sinuses and tuberculous granula- loyment certainly seems advisable (p. 400).

—Thoracotomy.—Simple incision of an empyemic cavity isable except in emergencies. Freezing or other form of local sufficient.

on of Rib and Drainage.—In double empyema, only one e operated upon at a time. The intercostal space in children that free drainage cannot be secured without the removal of a rib. If this rule is not followed, a soft rubber tube will be obstructed, while a hard rubber tube gives pain, or will pro- ure necrosis of the ribs.

cted cases the child will be so ill that the limbs and body must in cotton and an electric heated mattress placed upon the omize body heat and prevent shock. Local or general anes- ential. Stimulants and a hypodermic injection of morphia, digitalis, or scopolamin, in proportion to age, should be given The track of a previously successful tapping may be followed, n may be made longitudinally through the periosteum of the nth rib in the axillary line. A cross incision at either end per- on of the periosteum with raspatory or periosteotome without ura. One or two inches of the rib are then resected with heavy eps with lower flat blade, or with cutting forceps, or costo- oon saw. The pleura is punctured and pus allowed slowly to incision is then freely enlarged, the intercostal arteries caught atic forceps and ligated, the finger introduced and flocculi of ed with forceps. Irrigation should not be practised; a long tter. In adolescents much larger resections are advisable. If urfaces are adherent and a lung abscess disclosed, it may be knife or cautery. As the lung is already collapsed, there is less neumothorax than when a pleural cavity is opened upon a

If the patient is in fair condition, the author secures much closure of the cavity by passing into the first opening, a large- blunt probe (Fig. 162, p. 243) which is carried to the lowest abscess. At this lower point another resection is made and a rforated rubber tube drawn through from one opening to the week the tube may be divided in the middle and each end ily. In a few weeks one of the openings will show a diminu- nd may be allowed to close, the one producing the best drain- g open.[2] If a single opening is employed, several large tubes and secured by safety-pin and long black silk anchor line, to common accident of being lost inside the chest. The safest hort tube is a double flanged soft rubber button (Fig. 69).

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ans. Amer. Med. Assoc., Surg. Sec., 1909; Jour. Amer. Med. Assoc., Dec. 18, hsner, Ann. Surg., 1909, 50, 151.

Empyema, American Medicine, May 28, 1904, vii, 581; Monthly Encyclop.,

Bulky antiseptic dressings are applied and rigid asepsis enforced. Expansion of the lung will be favored by the frequent application of a large hyperemic cup over the opening in the chest.[1]

AFTER TREATMENT.—The tube may be shortened when only a seropurulent discharge is evident, strip gauze packing being substituted. Tubes are usually retained too long. The slowness of closure of a chest abscess depends largely upon the rigid ribs which prevent collapse and the adhesion of the granulation-lined walls. Sluggish granulation tissue may be stimulated with iodine, mopped or injected. Fetor at any period of treatment, unless there has been lung gangrene, means retention of pus and should be treated not by irrigation but by increased drainage. Very acute and unfortunate symptoms may be aroused by the injection of strong antiseptics. The original opening should be enlarged and a new one also made at the lowest point of the abscess, since at this period the patient will usually be walking about.

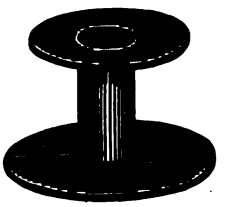

FIG. 69.—Rubber empyema drainage bobbin.

Various devices have been invented for excluding air, but with thorough antiseptic dressings infection will not take place.[2]

Tubes with nipples split at the end, to permit exit of pus without entrance of air, are sometimes employed. Martin proposes using a trocar and canula sufficiently large to carry in a tube, which tube is permanently inserted as a siphon inside a bottle of antiseptic fluid carried within the clothing.[3] Bryant also employs a permanent aspiration drainage appliance.[4]

Loss of Tube in Chest.—This is an accident that has frequently happened, the tube, though missed, having supposedly been carelessly removed in the dressing. Such tubes have remained in the chest for months, of course continuing the purulent discharge, and have sometimes only been discovered at the autopsy. Avoidance is best secured by use of the rubber bobbin or a tracheotomy tube, or by safe anchorage of the rubber tube with silk and safety-pin. If such an accident occurs, the original opening should be enlarged and the tube sought with the finger. Such manipulation is safer and less likely to produce injury than searching with forceps, and it also hastens cure.

Local pain is often due to impingement upon a nerve and requires a wider resection of rib, or the pain may be due to a blockade of pus by too early closure, in which case fever and constitutional symptoms will develop. A bacteriological examination of the pus should always be made to determine the existence of tuberculous or other organisms.

When sinuses with no signs of tuberculosis persist, thorough hygienic measures should be long continued, additional resections and excisions of sinuses being practised before [illegible] the larger rib resections. An out-

[1] Ann. Surg., Jan., 1910, 84.

[2] The author, after a personal experience of five months with drainage for pleuropneumonic empyema, lung abscess, and bronchial fistula, knows that absolute asepsis can be maintained and tuberculous or other infection avoided by a careful surgeon, such as Dr. Wharton.

[3] Jopson, Trans. Penna. State Med. Jour., May, 1907.

[4] Bryant, Operative Surgery, ii, 1027.

door life in healthful surroundings, and balsamic air, as described on page 380 are all-important and may result in complete closure.[1]

Lung Expansion.—Expansion of the lung is to be favored by cups over the wound, by deep breathings, laughing or crying, blow-guns, balloon whistles, blowing of soap bubbles and other games. A helpful and pleasing toy may be made by connecting two bottles partially filled with colored fluid. Through a glass tube the child blows the liquid into the upper bottle and then allows it to siphon back. The bag-pipe, spirometer and diaphragm exercises are excellent as well as arm and chest gymnastics.

Lateral Curvature.—Flattening of the chest and lateral curvature of the spine are to be prevented by special muscular exercises in a well-equipped gymnasium. Many cases of supposed lateral curvature are sent to the orthopaedic surgeon when the real difficulty is an undiscovered pleurisy (Fig. 70).

FIG. 70.—Deformity of chest following empyema. Lateral curvature and lateral tilt of body. Left shoulder line falls inside of left femur.

The author recently examined a woman forty-five years of age from whose chest when she was a child he had removed several pints of pus and had drained for months, yet whose spine was perfectly straight and chest measurements symmetrical.

THORACOPLASTY. — In children, collapse of the ribs after resection will usually take place and permanent cure follow. In old and neglected cases with lung contracted and bound down with strong adhesions, expansion to fill the huge bony-walled abscess cavity is unattainable. Obliteration is only possible by expansion of the lung, by collapse of the walls, and the adhesion of the granulation covered pleural surfaces. If the cavity persists and long-continued suppuration threatens amyloid changes or tuberculosis, large excisions of ribs with removal of all periosteum must be made. In adolescents, the Estlander and Schede methods are chiefly employed.

As extensive resection of ribs is an exceedingly serious operation the precautions advised on page 24 should always be taken. In Estlander's operation, two, three, or four inches from third to seventh ribs are sometimes removed, but these extensive resections are rarely required in children. The incisions may be multiple along the line of the ribs which are excised or a large U-shaped or a Z-shaped flap may be employed. After excision, the incisions are partially closed and the cavity drained. In Schede's operation, in addition to the ribs, the thickened parietal pleura and intercostal muscles are removed by a U-shaped flap extending from

[1]Willard, Open Air Treatment of Surgical Tuberculosis, Trans. Inter. Cong. Tuber., Wash., 1908, Section iii, vol. ii, 257; Southern Medical Journal, Dec., 1908; also Sunshine and Fresh Air, Jour. Amer. Med. Assoc., July 18, 1903.

the fourth costal cartilage in front, downward to the tenth rib laterally, thence upward to the level of the angle of the second rib posteriorly, everything being removed in one piece. The skin flap then falls back against the posterior pleural wall, is sutured in place and drained.

DECORTICATION OR PLEURECTOMY.—The dissection and removal of the entire diseased and thickened pleura as proposed by Fowler, has not been frequently practised. It consists in peeling the pleura both from the chest wall and from the lung to permit expansion of the latter.[1]

SEPARATION OF THE RIBS FROM THE STERNUM. — Jaboulay has advocated the separation of the upper six or seven ribs at the sternal articulation in order to permit collapse.

Prognosis.—The mortality of empyema in infants runs as high as 75 per cent. unless early operation is performed. Double empyema in young children is very dangerous, especially if septic, and is often accompanied by pericarditis.

If operation is delayed and the child septic, any operation becomes dangerous, yet it must be undertaken. Simple, quick methods, as tapping or incision, may precede the more radical one. Incision and drainage has given a death rate of 33 per cent.; excision and drainage 20 per cent., the mortality arising largely from the delay until the patient has become septic. The death rate from aspiration, incision, or resection *per se* is exceedingly small, if done early. In older children the mortality depends not upon the operation but upon delay in its performance; prolonged suppuration and amyloid disease causing deaths. After-results from postponement of operation are, crippled lung, contraction of chest, and lateral curvature. Absorption of pus should never be permitted, and spontaneous evacuation through a bronchus, or through chest wall, diaphragm, or psoas muscle is unjustifiable.

TUBERCULOUS CAVITIES IN THE LUNG.

The eradication of tuberculous cavities in the lung by injection or drainage or excision, has long been the hope and expectation of both surgeon and physician. If the disease was localized to a single focus, the surgical technic could be perfected to secure fairly safe accomplishment of the object, but, unfortunately, a single focus rarely exists; even at an early stage in children, multiple foci are the rule.

The operation has been occasionally practised and with temporary improvement in some cases. The great danger, aside from hemorrhage and lung collapse, lies in infection of the pleura and tuberculous empyema.

At the early and also hopeful stage the patient prefers to adopt the hygienic, dietetic, and open air treatment (p. 380) rather than submit to an operation which from the anatomical and surgical difficulties is much more serious than opening the brain or abdomen. Respiration is a vital function and cannot be arrested for even two minutes without serious results, while the abdominal organs are not as immediately connected with the processes of life. Except in isolated cases, or when the lung is adherent to the chest wall, the entrance of an external pressure of air upon the lung

[1] N. Y. Med. Record, Dec. 30, 1893.

unds to the square inch is followed by alarming symptoms
n.

portant preliminary step to operation, but which is seldom
children, is the accurate location of the focus by auscultation,
nd the X-ray.

owing are the principal operations employed:

PRESSION OF THE LUNG by the injection into the pleural cavity
or of nitrogen gas, 120 c.c. every three or four weeks, to give
ng and promote cicatrization.[1] (2) SUBPERIOSTEAL REMOVAL
rmit collapse of chest wall and compression of lung by plaster
acoplastic pleuropneumolysis. (3) ASPIRATION AND INJEC-
focus of medicated iodine solutions.[2] This method was advo-
sixteenth century and has been practised with varying success,
, carbolic acid, mercury, formalin, and other substances.
AND DRAINAGE—pneumonotomy; pulmonotomy. (5) RE-
THE DISEASED AREA—pneumonectomy; pulmonectomy.

perations have been fully described by the author in an ad-
irman of the Surgical Section, American Medical Association,[3]
able of 75 cases, statistics, bibliography and the opinion of
ors are given. The collection includes: 61 pneumonotomies,
ve recoveries of 64 per cent.; deaths 32 (of which 22 were
ortality of 50 per cent.; 6 pneumonectomies, with operative
67 per cent., but with 2 speedy deaths; 8 excisions of ribs,
e recoveries of 63 per cent., 3 deaths.

adds to these cases only four pneumonotomies. The ultimate
not be accurately traced.

at the Moscow Congress[5] reported 306 pneumonotomies with
of operative recoveries. Murphy collected 47 cases of lung
operated upon by various methods, with 19 deaths.[6] With
l universal air chamber pressure appliance of Willy Meyer[7]
pressure cabinet of Sauerbruch,[8] the positive method of
inson,[10] Crile,[11] and others,[12] and the pneumatic shield, the
neumothorax are now greatly lessened.[13]

Jour. Am. Med. Assoc., 1898 and Oct. 28, 1899; Lenake, Am. Med., 1902, 987.
Tr. Amer. Med. Assoc., 1880, 239.
Surgery of Tuberculous Cavities of the Lung Apex, Jour. Amer. Med.
), 1902; Experiments in Pneumonotomy and Pneumonectomy, Univ. Med.
2; Trans. Phil. Coll. Phys., 1891; Intrathoracic Surgery, Trans. Amer.
891; Am. Jour. Med. Sci., Dec., 1891; Jour. Amer. Med. Assoc., xxxix,
d. Jour., 1902, 1100.
. Surg. Assoc., 1909.
ner. Med. Assoc., 1898, xxx, 169; Wills, Jour. Amer. Med. Assoc., Aug.
nd Jan. 5, 1901, 19.
Jour. Amer. Med. Assoc., xxxi, 151-346.
eyer, Jour. Amer. Med. Assoc., Dec. 11, 1909, 1978.
ch, Trans. Surg. Sec. Amer. Med. Assoc., 1908; Jour. Amer. Med. Assoc., 1908.
Trans. Surg. Sec. Amer. Med. Assoc., 1908; Jour. Amer. Med. Assoc., 1908.
g., Feb., 1908, xlvii, 184.
ng Surgery.
Jour. Amer. Med. Assoc., Apr. 18, 1908.
, Transverse Sternal Thoracotomy, Tr. Amer. Surg. Assoc., 1909; Jour.
soc., Dec. 11, 1909, 1970.

The *dilatation of a bronchus*,—bronchiectasis,—sacculated and associated with interstitial pneumonia is not favorable for operative interference but is usually benefited by change of climate and life (see p. 380), especially if a balsamic air can be secured for its steady, daily influence of twenty doses per minute for twenty-four hours each day.

Iron, arsenic, iodine and hypophosphites will be of service.

ATELECTASIS PULMONUM—COLLAPSE OF LUNG.

Non-inflation of a portion or all of a lung at the first inspiration of a new-born child is a most serious drawback to its existence, especially when, as is usually the case, the infant is feeble. The feeble cry, shallow respiration and cyanosis following delayed parturition should lead to prompt measures for compelling the child to cry lustily. Spanking, intermittent anal pressure, hot and cold sprinkling, artificial respiration, mouth to mouth insufflation are ready methods. If the lung remains collapsed, the Fell-O'Dwyer artificial apparatus (Fig. 58, p. 81), or oxygen, or a vacuum cabinet, or positive pressure may be used.

Acquired atelectasis may occur from sudden entrance of air into the pleural cavity (pneumothorax) or from the blockade of a bronchus by a foreign body (p. 78).

DROPSY OF THE PERICARDIUM.

Tapping of Pericardium—Paracentesis.—The pericardium may require tapping for serous or suppurative or infectious pericarditis. The heart is usually pushed back from the pericardium by the fluid.

Aspiration.—Under thorough asepsis, the aspirating puncture is made at the left border of the sternum in the bulging fifth or sixth intercostal space. The internal mammary artery lies upon the triangularis sterni muscle, from four- to eight-tenths of an inch to the left of the sternal border. The pleural cavity is least likely to be punctured if the sixth intercostal is chosen but if a cartilaginous bridge joins the sixth and seventh ribs, the fifth interspace may be utilized provided the point of the needle is directed slightly downward. The pericardial sac in a child, if distended, will be reached at a depth of about one-half an inch.

Pericardiotomy and Drainage; Pyopericardium.—If pus is drawn, the line of the trocar may be followed by a straight or curved incision to the left of the sternum. Then resect the fifth, possibly also the fourth and sixth, costal cartilage, cut off and reflect the intercostal muscles, ligate the internal mammary artery, pick up the pericardium between two forceps and incise it. A soft drain tube—spirally cut—is then brought out at the lower border of the wound.

FOREIGN BODIES IN THE ESOPHAGUS AND PHARYNX.

A toothbrush bristle, or a fishbone or needle lodged in a tonsillar crypt or in the pharynx or in the lateral pharyngeal sulcus, will provoke such continual pricking and coughing that the object may be supposed to have

lodged in the larynx. Sharp bodies may migrate from the esophagus into the aorta or lungs. Irregular objects may ulcerate in any direction and cause abscess, suffocation, or death from asphyxia by pressure. Objects lodged in the esophagus, however, usually produce less coughing than when in the larynx, except when they press upon the rear of the trachea, but swallowing is difficult. Large objects of irregular shape, as jackstones, sometimes lodge opposite the prominence of the cricoid cartilage at the sixth cervical vertebra, or in the lateral pharyngeal sulci, or opposite the region of the left bronchus and produce asphyxia. A frequent point of arrest is above the cardiac orifice of the stomach. Illumination of the throat with head mirror, the laryngoscope, or the esophagoscope will often disclose the object. If metallic, the telephone probe or X-ray shadowgram will usually fix the distance from the mouth (Fig. 71). A definite knowledge of the position and character of the impacted body as determined by the finger, or bulbous probang, or X-ray, or electro-esophagoscope, is very important.

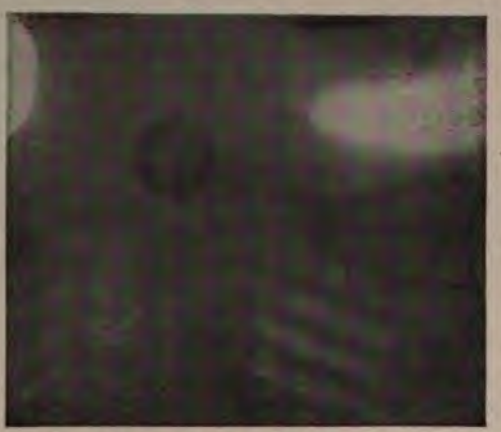

FIG. 71.—Metal button with long pin in esophagus. Removed by forceps through mouth.

Diagnosis.—The X-ray may also be employed for diagnostic purposes by administering large quantities of bismuth which when arrested at the point of obstruction will give a deeper shadow. A long small gold chain

FIG. 72.—Horsehair probang: *A*, closed for introduction; *B*, open. (Wharton and Curtis.)

swallowed to the blockaded region will also give a definite shadow with a Röntgen ray. A bougie believed to have been passed down to the stomach may be shown to have coiled itself at the stricture.[1]

Treatment.—If the obstruction cannot be reached or removed through the mouth, large boluses of food may assist in the downward progress or olive oil may be given in large quantity.

REMOVAL.—In the pharynx, the finger or a spoon handle is the speediest instrument at hand for removal of large objects, or a wire scoop may

[1] Surg., Gyn., and Obstet., Setp., 1908, 271.

be used. Fishbones or bristles can be caught with hemostatic forceps under thorough illumination. Tickling the throat will discharge the object by retching or vomiting, and succussion will induce coughing. Curved pharyngeal forceps, a flexible coin catcher, a dilatable umbrella horsehair probang (Fig. 72) or a lamp chimney brush are useful, if the object is in the esophagus beyond reach of the fingers.

To assist downward progress a BULBOUS ESOPHAGEAL PROBANG (Fig. 73*B*) may be cautiously used. After cocainization or freezing of the bulb with ethyl chloride, a mouth gag is inserted. The tongue is then drawn forward with a napkin and the bougie is guided by the finger past the opening of the larynx, the bulb being carried along the posterior pharyngeal wall. The distance of the obstruction from the incisor teeth should be marked. The probang is liable to be caught in mucous folds and all instrumentation must be cautiously done to avoid injury or perforation especially in cases of long standing with possible ulceration. (A missing object believed to have been swallowed has frequently been found later on the floor.) A pin or needle can sometimes be entangled in a sponge attached to a probang. Meat may be passed downward by a sponge probang. Inversion of the body adds the influence of gravity to heavy objects. Foreign bodies of irregular shape are more dangerous as they are liable to ulcerate through the walls. If the object becomes permanently fixed and abscess threatens, pharyngotomy or esophagotomy or gastrotomy may become necessary.

FIG. 73.—*A*, small metal balls (natural size), perforated to carry a silk cord. Progressive sizes to be swallowed at night (see p. 106); *B*, esophagus bulbous probang with long whalebone handle.

ESOPHAGOTOMY at the upper portion of the canal is usually performed on the left side of the neck in front of the sternocleidomastoid, the centre of the incision being over the foreign body. The anterior jugular vein may be tied, the inferior thyroid being avoided. The omohyoid muscle will probably require division and if made close to the hyoid bone, the descendens noni nerve can be avoided. The thyroid lobe, the thyroid muscles and the larynx are drawn inward. The esophageal obstruction may then be located by a bougie from the mouth, the wall of the canal picked up with forceps and incised between the superior and inferior arteries. The recurrent laryngeal nerve runs between the trachea and esophagus and must be carefully avoided (Fig. 57, p. 80). Care should be taken to make the incision in the esophagus of moderate size, dilatation or lengthening of the incision being afterward effected sufficiently to permit the grasping and cautious removal of the foreign body with forceps. The mucous and muscular coats should be sutured separately with catgut and the external wound partially closed and packed with gauze. Food should be given by the rectum for five

hich gentle pressure upon the sides of the wound during
ill prevent leakage.

much more serious position of entanglement is just above the
nce to the stomach, opposite the ninth dorsal spine, or the
drosternal juncture. At this point it is well to wait several
ope that the object will pass into the stomach and out of the
en large objects are frequently thus extracted safely through
o attempt at emesis or purgation should be made after the
e is passed, it being much safer to give an abundance of pota-
d to imbed the foreign body and permit it to make its way
gh the intestine and become thoroughly coated with feces.
arrest occurs at any point a CELIO-ENTEROTOMY may become
th extraction of the offending body from the intestine. The
e and the anus are the chief points of obstruction, the latter
ones. Richardson has demonstrated that a finger introduced
ervical esophagotomy wound, can reach not only the aorta
rried down to meet a finger introduced upward from the gas-
nd, thus exploring the entire tube. He advocates the dilata-
rdia with finger and the extraction downward of the body by
y a string and shot that have been swallowed and followed
Bull advises a primary GASTROTOMY: a string is then carried
nach wound up to the mouth by a small long bougie. To this
attached a sponge, which when drawn down to the gastric
secure the object. In case of permanent arrest of the foreign
ve the cardiac orifice, a gastrotomy should certainly be per-
mortality will vary from 20 to 25 per cent.

TOMY.—The approach to the esophagus through the posterior
d mediastinum has been attempted. Various ingenious oper-
cribed in Bryant's Operative Surgery and by Curtis and others.
as attempted ANTERIOR THORACOTOMY, but has failed.[1] The
ll-O'Dwyer artificial respiration apparatus (Fig. 58, p. 81) or
abinets for negative and positive pressure will greatly lessen
lung collapse,[2] if the pleura is opened.[3]

ESOPHAGEAL STRICTURE.

of the esophagus may be congenital or acquired. A very
e of cicatricial contraction (Fig. 74) is the drinking of lye, a
with young children on account of its resemblance to milk.
ld be given at once, followed by oil and an emetic. If acids
l, limewater or chalk should be taken; if carbolic acid, olive
tious passage of bulbous probangs should be commenced in
eek of healing to prevent contractile stricture. The resultant
is often followed by so great interference to deglutition that

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Trans. Amer. Surg. Assoc., 1891, 345; Trans. Surg. Sec. Amer. Med. Assoc.,
Amer. Med. Assoc., xxxvii, 1901, 1077.
er. Med. Assoc., Dec. 11, 1909, 1978, Willy Meyer.
g. of the Lung.

slow starvation results. The electric esophagoscope and bulbous probangs will determine the point of constriction. The X-ray will only occasionally give a shadow.

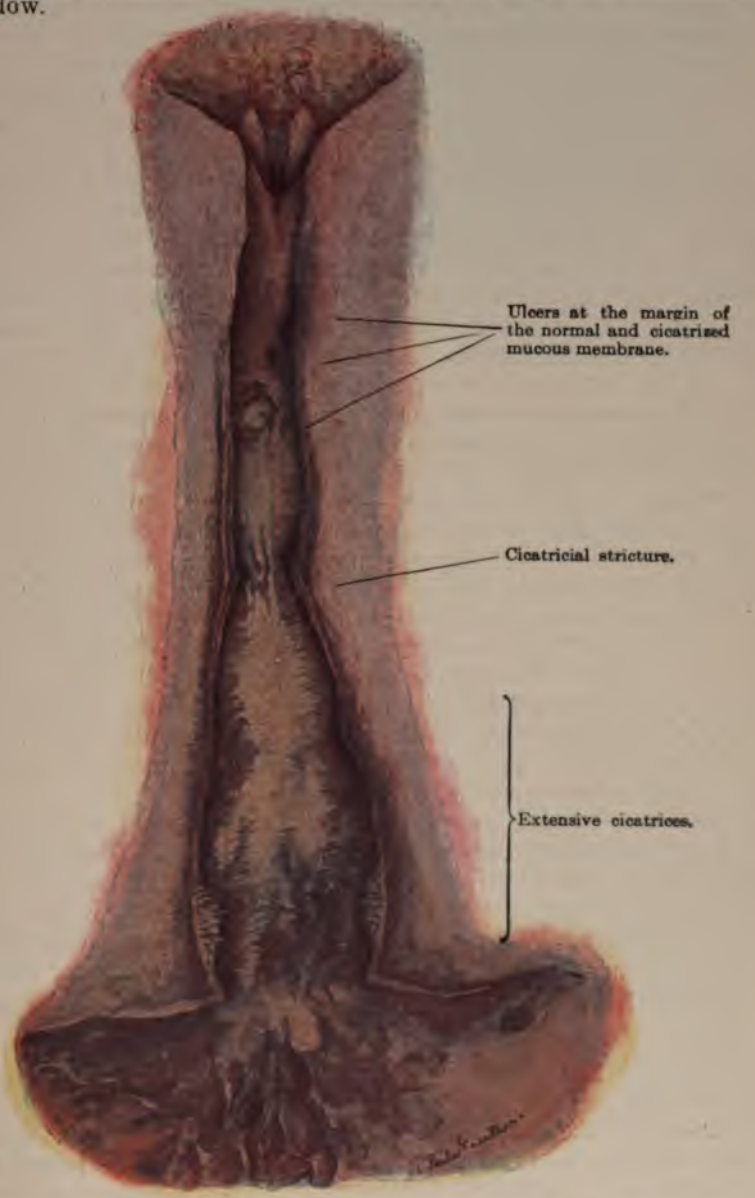

FIG. 74.—Ring-like stricture (corrosive) of the esophagus. Boy, aged 13 years. (Pfaundler and Schlossmann.)

Treatment.—BULBOUS BOUGIE DILATATION.—This method is the first one to be employed and if even the smallest bulb can be passed, a further dilatation with larger sized probangs may be expected. The operation will be at first resisted by the child but after it is discovered that the result is

of a larger amount of food, he will usually submit with more
praying of the fauces with cocaine solution, or freezing of the
with ice or with a spray of ethyl chloride will lessen irrita-
. The treatment is painful and prolonged and the esophagus
contract unless the operation is occasionally repeated for
frequency of the passage must depend upon the resultant
ulbs may be increased in size as rapidly as possible, or a
ugie used to hasten the process. Another excellent method
f METAL BALLS increasing in size (Fig. 73*A*, p. 103), to each
string is attached. A ball is swallowed at night and allowed
e esophagus in the hope that it will work its way down into
morning, when it can be withdrawn and a larger one swal-
night. The string is attached loosely to the ear or nightgown.
division by nicking the stricture with an esophagotome
cautiously performed.
t tubage is not well borne. Instrumentation for dilatation
sometimes be more easily accomplished through the nose
n. The passage of a bougie with a struggling child is always
ocedure.
DE DILATATION. — In permanent stricture esophagotomy
may become necessary.[1] A gastrotomy is first performed,
ng bougie is passed upward from the stomach wound through
fice and carried out of the mouth. A strong linen string or
wn downward from the mouth and out of the stomach wound.
otion the stricture is enlarged to enable bougies to be passed
h. Should the stricture prove impermeable, a permanent
should be established for alimentation. Even when a pas-
secured at the time of the operation, a small metal shot with
l may be swallowed and slowly find its way into the stomach,
arger cord may be made to follow.
STOMY.—Experimental attempts to reach the contracted area
eural route and to perform an esophago-gastrostomy have
preliminary intubation is as helpful as a tracheotomy, and
ficial respiratory apparatus, or a Fell-O'Dwyer or vacuum
tus and a chest wall flap, a gastro-esophagostomy, or an
ostomy will finally be perfected.[2] In extreme cases the cos-
e resected, together with the lower portion of the esophagus.[3]

MALFORMATIONS OF ESOPHAGUS.

AL ATRESIA will always be followed by death.
AL STENOSIS can sometimes be relieved by dilatation with pro-
geal malformations may be associated with imperforate anus.
ITAL POUCH OR DIVERTICULUM results from imperfect closure
cleft. If small in size, it may allow the passage of sufficient
the infant, but death is the usual result. Small diverticula

. Sec. Amer. Med. Assoc., 1908, 351.
Maury, Annals of Surgery, Oct., 1907, 544; Trans. Surg. Sec. Amer. Med.
Crile, Surgery of Lung.
urgery, Oct., 1908, 530.

occasionally persist and become so troublesome in after life as to demand esophagotomy or gastrotomy. The symptoms will be accumulation of food and its rejection undigested.

HYSTERICAL DYSPHAGIA in neurotic cases is benefited by the passage of bougies, by tonics and change of environment.

EDEMA OF THE EPIGLOTTIS.

Edema of the epiglottis and of the entrance to the larynx or vocal cords may occur from scalds or noxious vapors or acids or erysipelas. Inspiration will be difficult; expiration much easier. If ice internally and externally and astringent atomizations fail to relieve, intubation should be performed in preference to tracheotomy. Immediate puncture with a curved bistoury or curved tenotome guided by the finger of the left hand is more dangerous and should be done if possible with the aid of laryngoscopic illumination.

RETROPHARYNGEAL ABSCESS.

A retropharyngeal abscess, whether inflammatory from pharyngitis or softened lymphatic glands, or tuberculous from cervical spinal caries, should never be opened under anesthesia through the mouth, lest the pus pass into the larynx. Cocaine will lessen pain. After puncture the patient should quickly lean forward and discharge the mucus and pus, and then frequently disinfect the pharynx by gargle or spray.

Tuberculous spinal abscesses are best opened behind or in front of the sternomastoid. The incision is made downward from the mastoid process, the muscle, the deep vessels and longus colli being drawn forward by retractor. This route easily reaches the pus collection by blunt dissection by the finger-nail and the drainage and scar are placed in a favorable position.

CONGENITAL DEFORMITIES OF THE CHEST.

ABSENCE OR DEFICIENCIES OF THE STERNUM AND RIBS.—The sternum may be absent or deficient, either with or without congenital absence of pectoral muscles or of portions of ribs. Such defects produce either longitudinal or lateral sulci, or furrows in the chest wall (Fig. 75).

FIG. 75.—Transverse deformity of chest from rickets, ribs sunken.

DEFORMATION OF THE ANTERIOR PECTORAL REGION.—In a case recently observed by the author the thoracic portion of the pectoralis major was fairly prominent while the clavicular portion was absent. The anterior axillary fold was a thin

sheet. All the ribs beneath this were very prominent, somewhat flattened, and the serratus magnus was defective. Two nipples on the one side were also present in this patient, a male of five years.

Gymnastic muscular development is the only remedy for these malformations.

PIGEON BREAST.

Synonyms: Pectus carinatum; chicken breast; keel chest.

FIG. 76.—Deformed chest, with normal shoulders. Note transverse wrinkle at epigastrium.

Pigeon breast is a deformity of the sternum in which the bone instead of presenting a flat anterior aspect projects forward more or less sharply from the junction of the ribs with the cartilages. It is usually accompanied by signs of rickets, as beading of the ribs, bowed legs, etc. It may be caused by interference with respiration from enlarged tonsils, or adenoids, or as the result of the chest deformities of high dorsal caries. In the latter case, this deformity is sometimes accompanied by tilting forward of the lower end of the sternum, marked projection of the ninth and tenth costal junction of the ribs, with a marked wrinkle in the abdomen (Fig. 76).

Treatment. — Deep breathing, suspension of the body by the arms from bar, rings, or trapeze, general gymnastics, forcible manual compression, and the attachment at night of a shot bag upon the projecting bone are the measures to be employed. When associated with spinal caries, gymnastics are unsuitable.

DEPRESSED STERNUM; FUNNEL CHEST.

Inward bending of the sternum and of the anterior extremities of the ribs is usually found in rickety or feeble children. Adenoids, enlarged tonsils, or laryngismus stridulus may so interfere with the entrance of air into the lungs that a partial vacuum is formed in the chest during inspiration. Atmospheric pressure together with excessive but ineffectual contractions of the diaphragm will cause the ribs to bend at their softest area.

Treatment.—Open air treatment and antirhachitic remedies should be given after removal of the obstructive cause. Hand pressure by mother or nurse, deep inspirations, and properly conducted muscular exercises in an orthopaedic gymnasium, with special attention to upper chest muscles by trapeze, rings and bar, in early life will greatly assist in the proper development of the chest walls.

FLAT CHEST.

Flat chest of varying degrees is met with in children from faulty position and is usually accompanied by round shoulders. Deep breathing and gymnastic exercises arranged for round shoulders (p. 283) are to be used, especially self-suspension by the arms.

A depressed sternum forms the FLAT or bellows chest; a gutter, the FUNNEL chest.

An ABSENT STERNUM may result in ectopia cordis. A projecting angle at the lower end of the manubrium is known as the angulus sterni or Ludovici.

BEADED RIBS or the RICKETY ROSARY occur from enlargements of the costochondral junctions.

MEDIAN FISSURE of the sternum, except BIFID ENSIFORM CARTILAGE, is rare.

MASTITIS OF NEW-BORN—NEONATORUM.

This inflammatory condition is due to attempts at milking the breasts by the midwife or officious interference by the nurse. If handling is avoided, and hamamelis ointment and light pressure applied, the hardening will subside. The MASTITIS of young girls arising from traumatism or during menstruation will subside with rest and the use of hamamelis or boric ointment.

MAMMARY TUMORS.

Mammary tumors in children are usually benign. ANGIOMA or vascular tumors may by their size produce atrophy of the breast tissue. These and fibro-epithelial growths may exist from birth in either sex.[1] ADENO-FIBROMATA develop as the child approaches puberty. CYSTIC diseases and LIPOMA are rare.

In benign tumors, if operation becomes necessary in boys, the tumors may be freely removed; in girls a conservative plastic operation is better, the breast being turned upward as a flap and the growth carefully dissected so as to injure the milk tubes and nipple as little as possible.[1]

Malignant tumors, carcinoma and sarcoma are very rare in childhood.

MAMMARY MALFORMATIONS.

SUPERNUMERARY NIPPLES (polythelia) occur both in boys and girls. SUPERNUMERARY MAMMÆ (polymastia) to the extent of three or four may occur upon the abdomen, or they may be found in the axilla or on the thigh. ABSENCE OF BREASTS (amastia) is rare, but may occur in connection with other pectoral deformities. Supernumerary breasts usually need removal for cosmetic appearance only.

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[1] Jopson, Ann. of Surg., Nov., 1908, xlviii, 622.

CHAPTER IV.

SURGERY OF THE ABDOMEN.

APPENDICITIS.

ITIS is the most common and the most important surgical dis-
lomen in children. To discuss it in its entirety would require
equently the condition will be considered chiefly as it presents
life, varying as it does in some particulars from the disease

itis is an infectious inflammatory condition of the vermiform
eeding from a variety of causes. In slight cases it may end
or permanent quiescence or in obliteration of the calibre,
jority of instances it progresses to perforation, abscess, gan-
lent peritonitis. The cases classed under this head to-day
conditions formerly denominated TYPHLITIS, PERITYPHLITIS,
ONITIS, etc.[1] The author when an Interne, posted many
the gangrenous purulent process in the right iliac fossa was
the *result* of the peritonitis, not the cause.

al Peculiarities.—The anatomical conditions presented are
sible for some of the differences in children as to the symp-
gnosis, the progress, and the treatment. The appendix is
he contraction of the embryonal cecal pouch. The organ is
and more anterior than in adults[2] and the lumen is larger.
ent position is downward and inward from the cecum, but the
ion is also a common one. In the new-born the organ has no
n. Ribbert gives its length in infants as one-tenth that of the
. The short mesappendix in children especially exposes the
n to kinking and to thrombosis. If the lumen becomes nar-
ecal extremity preventing free exit of fecal accumulations and
nts, ulceration and perforation from pressure necrosis are
ther anatomical peril is the shortness of the omentum which
m forming an enclosing wall about the inflamed appendix.
tissue in the appendix is abundant, rendering the young
infection after catarrhal enteritis. The mesappendix (MES-
carries the vermiform appendiceal artery, a branch of the
ion of the ileocolic (Fig. 77) from the superior mesenteric.
npty into the ileocolic portal system. The anterior LYM-
ect with a persistent lymph-node at the fold between the
ileum (Fig. 78), with communications with the mesenteric

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rticle on Appendicitis, Gould and Pyle's Cyclo. Med. and Surg., 1900;
, Nov., 1901, 648; Trans. Phila. Path. Soc., 1894, 40.
natomy, 1669.

(Fig. 79), the posterior nodes in the iliac fossa, those to the left of the ascending colon and with the ovarian system.[1]

Etiology.—AGE.—In children from eight to sixteen years, appendicitis is especially common, a very large majority of all cases appearing before the age of fifteen. This is the age of activity and restlessness inviting trauma. In addition, indiscriminate eating and exanthematous and catarrhal dis-

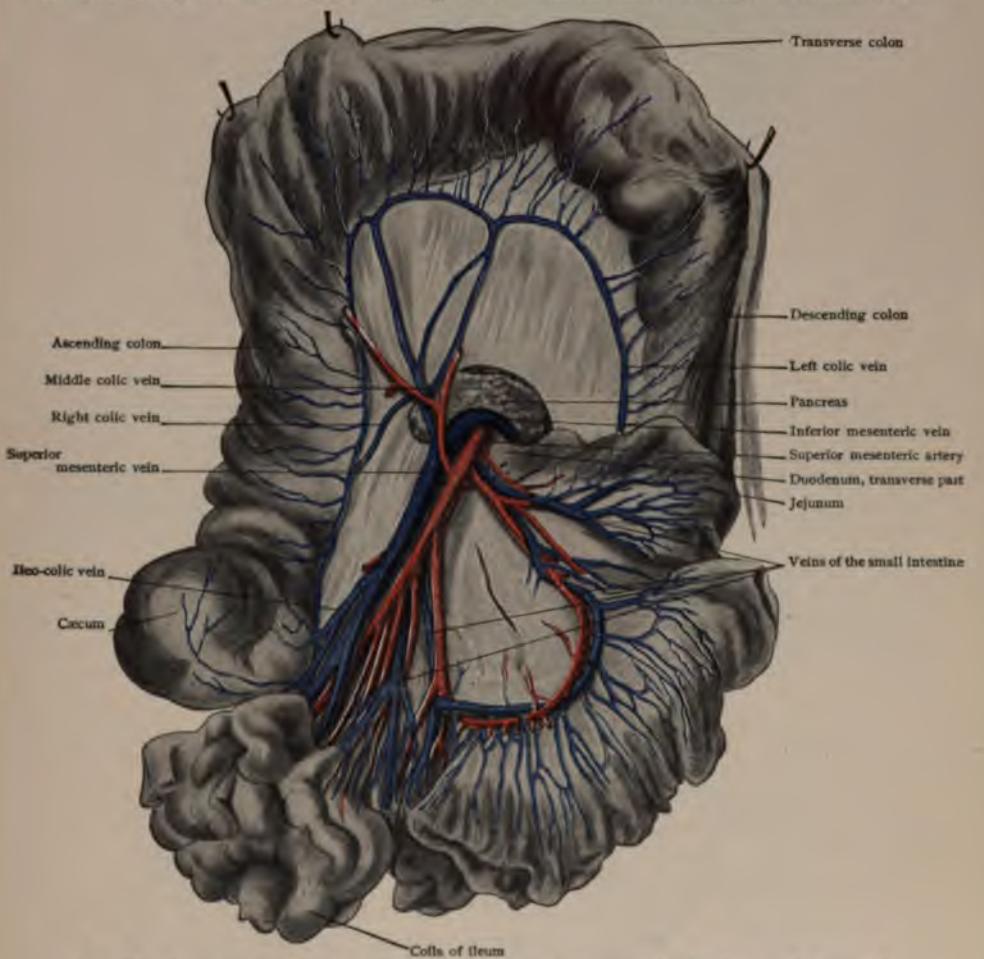


FIG. 77.—Superior mesenteric vein and its tributaries; transverse colon has been pulled upward. (Piersol's Anatomy.)

eases are common, while the lymphoid structures are especially overactive. In infants and children under two, the disease is rare, as the majority are guarded from injuries and their diet is controlled. Operation has been done however in the first days of life; under five it is exceptional.[2]

SEX.—The preponderance of the disease in males is evident even in very young children, probably due to the more abundant blood supply and

[1] Piersol's Anatomy, 1668.
[2] Griffith, University Med. Bulletin, 1901, 300.

the smaller lumen of the organ in girls. In older children the greater frequency of trauma in boys readily accounts for its increased occurrence.

Many causes undoubtedly favor the infection by microörganisms of the lining membrane of this poorly-nourished vestigial structure. When the vital resistance is lowered by GRIPPE or other CATARRHAL affections, by

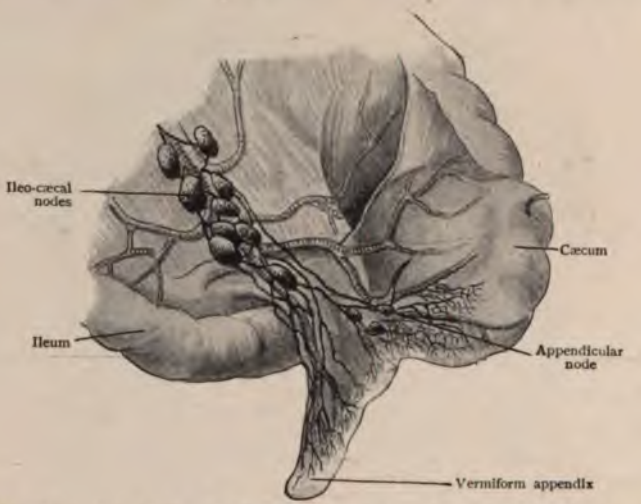


FIG 78.—Ileocecal and appendicular lymphatic nodes and vessels (Polya and Navratil). (Piersol's Anatomy.)

FIG. 79.—Mesenteric lymphatic nodes and vessels; peritoneal covering of mesentery has been removed. (Piersol's Anatomy.)

scarlatina or other disease, or by intestinal disorders which are so common in children, an infection by the colon or other bacillus is easy. FECAL CONCRETIONS are found in many cases. Their influence as a cause of appendicitis is well established. Their presence produces frequent slight traumatisms of the mucous lining and provokes spasm of its muscular fibres. Repeated slight inflammations invite thickening of membrane and further

infection, ending in stricture or in ulceration or perforation. While these fecal masses may have a seed as a nucleus, such condition is exceptional. FOREIGN BODIES other than fecal concretions, often considered as a cause, will be but rarely found in the appendix. The author recalls but two such

FIG. 80.—*A*, large appendix. Subsequent examination demonstrated lumen dilated the entire length by fecal obstructions; *B*, twist and kink of appendix caused by short mesentery. Fecal matter in lumen; *C*, twist and kink of appendix greatly exaggerated; *D*, foreign body in lumen of appendix. X-ray. (Deaver, Keating's Supplement.)

cases in all his operations, one a pin, the other a piece of tinfoil from candy.[1] ADHESION of the tip of the appendix is likely to cause kinking, bending, or torsion when any unusual distention of the cecum interferes with or cuts off the circulation through the mesappendix (Fig. 80). Repeated attacks of

[1] Willard, Tr. Phil. Path. Soc., xvii, 40; Kelly, Appendicitis, p. 366.

from this cause may narrow or close the lumen and prevent of the contents into the cecum.

ISMS.—Injuries, kicks, or blows, undoubtedly favor the con- ally if a fecal concretion is already lodged in the organ.

AL WORMS are so common in children that it is not strange that times found accidentally in connection with appendicitis.

Y.—The author has in a number of instances operated upon ers of the same family. This would seem to indicate an inher- nce, yet such condition may have arisen from a similarity of d, or of environment.

OLITIS and other digestive troubles are especially common in re also constipation and diarrhea and may lead to infection.

y and Bacteriology.—Many varieties of micro-organisms have n the lymphoid tissues of an appendiceal inflammation, the being the most common, but streptococci, staphylococci, or may also be present. In fetid gangrenous cases, anerobic sometimes be discovered. The omentum being freely sup- od makes an excellent blanket for closing in an inflamed or pendix, as it adheres in a few hours and forms an excellent hildren it is unfortunately so short that it is unable to thor- m this office and spreading general peritonitis may follow. eration, perforation, and gangrene occur early and toxic pro- n disseminated through the general peritoneal cavity within ty-four hours.

tion.—Clinically, the cases are ACUTE, SUPPURATIVE, or there are so many varieties of appendicitis that it is difficult m accurately.

most serious cases are of the acute perforative variety with ectious peritonitis, without walling in of the toxic material. ve gangrenous appendicitis, with the products confined to the organ. (3) Acute infections with severe symptoms, nonper- accompanied by local peritonitis and by adhesions of mesen- stines,—plastic cases. (4) Subacute, with mild symptoms. r latent, in which a variety of local or distant symptoms may (6) Recurrent, with history of one or many slight or severe n in the right iliac fossa. (7) Catarrhal. (8) Tuberculous.

s.—From a slight discomfort which in children may pass be considered only as indigestion or colic, the symptoms will of an intensity which in twenty-four hours may destroy the quently and unfortunately the symptoms *do not supply an* eriousness of the infection and both mother and physician may t manifestations until too late.

n typical cases sudden acute abdominal pain will be the initial n a child unable to talk it may be mistaken for colic, or for the r (hunger in babies is undoubtedly a pain). In older children y be attributed to indigestion since it is often located in the o colic if it is at the umbilicus. The pain may be slight or nittent or continuous, and while it may at first be in any por- domen, it gradually centres in the right iliac fossa. Its loca-

tion at the region of the umbilicus is readily explained by the route of the superior mesenteric system of nerves in the mesentery.

Unusual locations of pain are sometimes due to peculiar positions of the appendix. The author recalls finding in one of his operations for volvulus with a long mesentery, a sloughing appendix lying in the LEFT HYPOCHONDRIAC region near the spleen. In another case with large pus collection, the only pain throughout the attack was located in the VAGINA.

VOMITING.—The early occurrence of evacuation of the contents of the stomach still further tends to indicate indigestion, but in appendicitis the vomiting *follows* and does not precede the pain as is the rule in indigestion. While the vomiting may diminish for a time, it will recommence in the advent of peritonitis, or if food or drink or medicines are given by the stomach.

TENDERNESS.—Tenderness over the region of the base of the inflamed organ is soon apparent. Its most common point will be at the base of the appendix at a line joining the anterior superior spinous process of the ilium and the umbilicus and just at the outer border of the rectus (McBurney or Munro). The organ is situated higher in children than in adults. The surgeon in examining the bared abdomen of a child should always proceed with the utmost caution since diagnosis in a crying child is most uncertain. He should first palpate the left and the upper regions, gently approaching the suspected area, while with the other hand he compares it with the opposite side. During this procedure the thighs should be flexed. A thumb placed at the same time in the right lumbar region will give double palpation but care must be taken not to rupture delicate adhesions. A sudden increase in tenderness with tympanites usually means perforation.

RIGIDITY OF THE RIGHT LOWER QUADRANT.—Rigidity of the right rectus muscle is an early, constant and reliable sign of an endeavor on the part of the muscles to protect the inflamed organ beneath. By cautiously palpating the two sides simultaneously and alternately, the difference will be readily distinguished. This rigidity differs from the later tension of the entire abdomen produced by the tympanites of intestinal paresis in peritonitis.

PULSE.—The pulse in children will almost invariably be quickened from the onset but no more than in ordinary gastric disturbances. As the disease progresses the rapidity will increase to 140 or 160 while the volume will diminish, especially if pus has formed.

TEMPERATURE.—The temperature in children, as in adults, rapidly rises in the initial stage, but this is the rule even in digestive troubles; it is only diagnostic when taken in connection with the sequence of symptoms, as 102° or 105° is not uncommon even in slight disorders; later, after septic absorption, 103° to 106° may be reached. A steadily increasing temperature, with rise in pulse-rate, is significant and demands immediate operation with drainage.

HEMATURIA[1] and chills are not common, except at the ushering in of pus formation.

CONSTIPATION is the rule, diarrhea the exception, but the colon may empty itself without discharge of the contents of the small intestine. The passage of flatus is obstructed.

[1] Annals of Surgery, Sept., 1908.

TES.—While the leucocyte count may be very misleading if one yet when taken in account with and interpreted by the clinical symptoms, it is of service. The absence of leucocy- ken by itself, may indicate either a mild infection or one so sistive power is destroyed.

rential count is more helpful. Many observers seem to agree ion between the total leucocyte count and the percentage of uclears is the more valuable indication. Taking 75 per cent. r neutrophiles as the average of health, a polynuclear count er cent. shows a dangerous process demanding speedy opera- 0 per cent. the danger increases and peritonitis is probably ow 80 per cent. indicates a much milder process, either simple Between 80 per cent. and 85 per cent. and in exceptional ain. When in doubt, operate. Of course these percentages pared with clinical symptoms in each individual case. A does not necessarily mean pus but is a more certain indica- ple leucocytosis. The lowering of the percentage may also bility to further resist infection.[1]

n the normal percentage of polynuclear cells is much lower than t that must be taken into account in interpretation. The wise one who carefully studies the clinical symptoms, remembering ucocytosis may mean an active resistance, and a low or falling failure in resistance.[2] Several examinations by one observer eliable. A high percentage of polynuclear cells may not be ser- the absolute number of white cells is high. A rise to normal e number of mononuclears and eosinophi es is favorable and bsolute number of polynuclears while the total percentage of s is decreasing, tends to show that the infection is lessening. le sign is the sudden fall in the total number of leucocytes.

-The infectious process advances either rapidly or slowly ac- e severity of the attack. In simple cases the appendix may tents into the cecum, or a kink or a flexion may be straight- dence of distention of the cecum and all symptoms subside, n a few days or weeks or months if the appendix has not erated during the primary attack. Unfortunately in many gerous infection. the symptoms *apparently* subside and the misled by this quiescence, which may really mean a lack of r, with gangrene. It is a period that requires the most acute servation and the exercise of a diagnostic insight that is pos- few physicians and surgeons. As long as any of the symp- and especially the local tenderness, vigilance should not be est in bed should be enforced. In advancing cases, tender- and pain increase. If the appendix ulcerates or perforates h local peritonitis confining the products by agglutination and neighboring coils of intestines, a tumor of irregular shape hich often passes on to abscess. In virulent infections where forces are overpowered, the gangrenous pus, having no lim-

[1] Fowler, Surg., Gyn. and Obstet., Sept., 1908, 308.
[2] Deaver, N. Y. Med. Journ., Feb. 2, 1907.

iting wall, may quickly make its way into the general abdominal cavity and a rapidly SPREADING INFECTIOUS PERITONITIS follows. In such a condition all the symptoms suddenly increase, the pulse is frequent and thready, the temperature rapidly rises or becomes subnormal, the abdomen quickly distends and becomes tense from the tympanites of intestinal paresis. The child's face is pinched, the vomiting becomes the greenish gulp of peritonitis, and rapid collapse ensues unless prompt action is taken. Pain may be absent, or it may be intense at the time of perforation. A young child becomes speedily restless, then relapses into coma. The knees are drawn up to relieve tension on the tender abdomen. These gangrenous cases are the most dangerous and the most deceptive of all, as without warning the symptoms become suddenly extreme and death takes place in twenty-four hours. If they withstand the primary shock, septic spreading peritonitis with obstipation, dulness, coma, delirium and death follow.

FIG. 81.—Perforation of the appendix (Kelly).

Abscess.—If the resistive powers are in good condition and time is sufficient, a perforated or inflamed appendix may be walled in by a localized peritonitis and plastic lymph formation that agglutinates neighboring oils of the intestines and the omentum. If the infection is mild, this tumor may remain quiescent and possibly permanent. As a rule, if untreated, pus will make its way into the bowel, rectum, bladder, vagina, or through the abdominal wall, or down the psoas to the thigh, according to the position of the appendix. Its infection carried by veins into the portal circulation may result in liver abscess, thence be distributed to lung and heart with resultant septic pneumonia or pericarditis, especially in feeble children. Postperitoneal, subphrenic and other abdominal abscesses are common. Phlebitis of either right or left leg from septic thrombosis is not infrequent. Adhesions and bands thrown across the intestine often cause obstruction of the lumen and together with multiple abdominal abscesses may compel a second operation.

Complications.—The complications of appendicitis in addition to those already noted under abscess may arise from unusual positions of the organ. One of these is the presence of the appendix in a congenital or acquired hernial sac. The author on several occasions in hernial operations has found both cecum and appendix in this position. In girls, pelvic inflammations, or twisted pedicles, may coexist.

Chronic Appendicitis with Recurring Attacks.—In recurrent appendicitis when the pathological conditions are such as to produce intermittent

in the lumen, or when a walled-in perforation is so small as to
ge of only liquid feces during diarrhea, exacerbations often
nt that they are mistaken for dyspepsia or other disease and
l to continue for months or years until a violent infection leads
us results, perhaps death. Especially are these attacks dan-
ths disinclined to admit of pain and indifferent to digestive

AL appendicitis in children with congestion of mucous lining
ippe or other mucous catarrhs and temporarily interfere with
drainage into the cecum, or it may follow temporary bending
from distention of the colon. A single attack or several may
ning, stricture, or ulceration.

s.—While a typical case of appendicitis is easy of diagnosis, the
s will not only puzzle the most astute and experienced phy-
rgeons but will often baffle them completely, and, on opening
, unexpected conditions will be disclosed. Professor Agnew,
stic acumen has never been excelled, said, "no surgeon can
onditions that will present themselves within the abdominal
cardinal symptoms, *sudden pain* beginning in any portion of
but usually finally locating in the right iliac fossa, *vomiting*,
ss and *rigidity*, are the ones upon which the surgeon must rely.
mperature, leucocytosis, etc., are accessories that are to be con-
ir uncertain values. In children under two years of age, pain
are so frequently the accompaniments of colic and indigestion
ract special attention until too late. The constant crying and
colicky hand-fed children is of course misleading. In older
len violent attacks are always suspicious. Every abdominal
hild should receive a most thorough examination of the bared
a child in perfect health and without known indiscretion in
cked with sudden violent pain in any portion of the abdomen
vomiting, the physician should not assume that it is only
stion but should carefully watch for symptoms of appendicitis
the abdomen frequently. Acute indigestion may give a higher
er distinctive symptoms of appendicitis will be absent.

ptoms of tenderness and rigidity are also masked, since an
y and hold its abdomen rigidly under even gentle manipula-
derness and rigidity are the most reliable signs as they are
ntly present. A diagnosis is to be made only by the complex
al and constitutional signs. If *opium* has been given, the
be made much more difficult on account of the masking of
s. A temporary lull of symptoms must never throw the sur-
guard, as perforation and gangrene may have occurred from
istive powers. The sudden disappearance of pain and high
relief of other symptoms is an indication of danger.

NIC APPENDICITIS, even between attacks, tenderness can be
the appendix and in some cases the indurated organ can be
he appendix may be in the pelvis or postcecal or in the umbil-
ider, or other regions. All manipulations should be made
ith simultaneous comparison with the opposite side. Many

cases of obscure chronic digestive troubles will disappear as by magic after an irritable appendix has been removed.

When an abscess has formed, it can sometimes be discovered through the rectum or through the vagina in large girls. In late cases with localized abscess the tumor may be palpated in the iliac fossa or loin or pelvis or in umbilical or even left inguinal region.

Differential Diagnosis.—The family practitioner has now become so thoroughly imbued with the idea that appendicitis is an all-prevalent disease that he considers his reputation better conserved by denominating every unknown condition as appendicitis, and the consulting surgeon has to be constantly on his guard not to be led astray by inadequately observed symptoms. Many cases of pleurisy and of pneumonia, phlebitis, and disease of other distant tissues are mistaken for appendicitis. In contradistinction to the error, however, are the many cases of appendicitis that are wrongly diagnosed as pneumonia, pleurisy, etc.

In diagnosis the surgeon must keep in mind the following principal diseases and the presence or absence of special symptoms: (1) infantile colic; (2) acute indigestion; (3) cholera morbus; (4) ptomaine poisoning; (5) enterocolitis; (6) acute intestinal obstruction; (7) intussusception and volvulus; (8) peritonitis, acute and tuberculous; (9) fecal impaction; (10) trauma of abdomen; (11) typhlitis and perityphlitis; (12) rupture of gall-bladder and cholecystitis; (13) biliary colic; (14) kidney colic; (15) psoas and iliac abscess; (16) hip-joint disease; (17) pneumonia and pleurisy; (18) bronchitis; (19) typhoid fever; (20) hernia and undescended testicle; (21) in girls after puberty, menstrual pains, ovarian neuralgia, gonorrheal salpingitis, etc.

The picture of the main symptoms of each of these diseases should come before the surgeon in every doubtful case. It is his duty to use his brains before employing the knife; the reverse seems to be the rule with some surgeons at the present day.

It should be remembered that an individual may have pain and inflammation in the right iliac region without having appendicitis, although the latter is the most probable cause of trouble. Spellissy reports sixty-eight species of lesions that may occur to confuse the diagnosis.[1]

Prognosis.—In infants under one year of age, nearly all cases are fatal, largely from the delay in diagnosis. Under two also, operation is usually postponed until success is unattainable. The higher mortality in children is due to their inability to describe the symptoms, or to the carelessness of parents in observing indications which are usually ascribed to indigestion. In children under six the prognosis is always serious; from seven to fifteen the results are somewhat better than in adults, provided early operative relief is given. The prognosis in any acute case is a doubtful one. While many patients undoubtedly recover without treatment, yet an infection apparently simple at one hour may in a half day assume the most serious aspect and even, in spite of operation, destroy life. The elements in prognosis are first the virulence of the infection and second the treatment and the promptness of surgical intervention. The only safe rule in children is to operate early, as the appendix must be removed before it is perforated.

[1] Spellissy, Annals of Surgery, xxxv, 758.

where symptoms are progressively increasing, operation is
re will be but few exceptions to this rule in childhood even in
hich have passed forty-eight hours and show signs of infectious
These cases Richardson has described as "Too late for an early
too early for late operation." Cases that are actually mori-
ated upon, will bring discredit upon the surgeon, but even
es, especially in adolescents, can be snatched from the grave
ected treatment.
in an analysis of 1000 cases of appendicitis gives the follow-

	Cases.	Mortality.
ppendicitis and interval operations	540	0.5
pendicitis without perforation	255	1.9
rforated, or gangrene without abscess	55	0.
rforated with abscess	117	3.4
th diffuse peritonitis	33	30.
Total	1000	2.2

udes that even in the dangerous cases in which perforation and
nitis are already present the mortality can be reduced to less
cent. if properly treated (p. 121).
of acute appendicitis operated in the first forty-eight hours, the
not be above 1 per cent. In interval operations the mortality
cally nil. In desperate cases with diffuse spreading infectious
e mortality of cases will be high, depending largely on the
tituted (p. 125). The prognosis in all children too young to
reatment is very unfavorable, but in adolescents the recuper-
re excellent and recurrent cases with interval operation will
Nearly 80 per cent. of deaths are from peritonitis; septicemia
t most frequent cause.
ses Holt found that of 52 cases ending in abscess, 40 had gen-
s and 11 ended in resolution. Of 6 neglected cases, 4 opened
m, 1 externally, and 1 into the peritoneum, causing death.
t.—Appendicitis is a surgical disease and should be so con-
its onset but both physician and surgeon are frequently
arriving at the diagnosis. No physician or surgeon has yet
able positively to decide that a case with slight symptoms
few hours become a gangrenous perforation with a spreading
Those who profess to have the greatest acumen are obliged to
in cases that end either in resolution or in death, that the
ological condition was uncertain. With this fact in mind
n in the first twenty-four hours in children will as a rule
e removal of the appendix with the lumen intact, there should
r hesitation AS SOON AS THE DIAGNOSIS IS EVEN REASONABLY
e cases that might go on to resolution are an uncertain
will not counterbalance those doomed to peritonitis by delay.
eration, before the appendix ruptures, gives practically no mor-
nvalescence will be short, complications avoided, adhesions,
ecurrence prevented. Delay for two or three days means
ection, peritonitis, and even if death is escaped, tedious drain-

age, septic secondary abscesses, adhesions, intestinal obstructions and hernia; in girls, in addition, it means adhesions or other implications of ovary or tube, rendering menstruation painful and parturition difficult.

STARVATION METHOD.—In young children, it is impossible to withhold food or to practice lavage since crying and struggling may produce even worse results than peristalsis. The same is true of many uncontrollable older children in whom the treatment as proposed by Ochsner is inapplicable and operation is therefore essential to save life. Undoubtedly, in all cases where it can be employed, this starvation treatment is of great service from the very beginning of the attack, in order to limit peristalsis and give rest to the inflamed area. No food, no water, no cathartics are to be given. The stomach in large children is to be washed out at once and as frequently as indicated by the vomiting, the throat being sprayed with cocaine and the end of the stomach tube being frozen. Absolute rest in bed is to be enjoined. Water or peptonized foods may be given in small quantities by the rectum, or the patient may be laid in a bath of warm water or milk. The avoidance of purgation and enemata will diminish mortality.

From the moment that appendicitis is suspected, and even after operation in extreme cases of diffuse peritonitis in older children, Ochsner does not permit a particle of food for four days, the patient being allowed, with proctoclysis, only small rectal injections of concentrated foods, with rinsing of the mouth. By this method, with perforative and general infectious peritonitis cases he avoids spreading of the infection either by peristalsis or by operative manipulations and converts a dangerous case into one of less degree, with opportunity for safe operation later. He claims that he has lost no acute case of appendicitis when this method has been practised from the inception, and when nothing has been put into the stomach, that even in spreading peritonitis, the mortality can be greatly reduced. The misinterpretation and misapplication of this treatment has, unfortunately, been the excuse for many cases of inactivity and procrastination and has caused many deaths.

OPIUM and MORPHIA have lulled to the grave many a child that without their use might have been diagnosed and saved by timely operation. *After* operation has been decided upon and preparations are being made, small doses of opium may be given to quiet excessive pain during transportation to the hospital. Previous to this time, pain should have been limited by ICE-BAGS and by oil of peppermint over the appendix. Severe pain demands immediate operation, not morphia.

CATHARTICS.—The old plan of persistent irritation of the bowel and the stimulation of peristalsis by repeated and powerful cathartics should be abandoned as it has been responsible for many deaths.

INJECTIONS.—Enemata are useful in cleansing the lower bowel.

ICE-BAGS in tractable children will often relieve pain, but have little or no influence upon the infection.

Operative Technic.—The surgeon in operating for an ACUTE SUPPURATIVE APPENDICITIS must be prepared to meet with many obstacles, since each operation is practically an exploratory one and he will be fortunate, especially in girls, if he does not encounter unexpected difficulties. If the appendix is found healthy, the hernial openings should always be examined,

-bladder, pelvic and other organs. As children bear shock
odies must be thoroughly protected with cotton and a warm
tress employed. Thorough asepsis is essential. Solutions
l sparingly in washing, as they chill the patient. In urgent
should be quickly made sterile by tincture of iodine.
will differ according to the situation of the infection and the
operator. They have been made at various points from the
o the loin. They should as a rule commence outside of the
ove a line drawn from the umbilicus to the iliac spine, and
h or many inches in length, being extended according to the
he case. The operative indications to be fulfilled are: to
men with as little injury to the muscles, nerves and vessels
t with safe and efficient removal of the products of infec-
e the appendix when it can be done without further infecting
cavity; to open and drain cases of septic infectious perito-
uickest possible manner; to operate on chronic cases in the
en attacks.

cases, where operation can be secured on the first or second
RATION OF MUSCULAR FIBRES, as described on p. 127 for in-
ns, should be employed as a preventive of subsequent hernia.
vered, either the oblique or vertical incisions may require to
y enlarged in complicated cases by curved or lateral or trans-
y-stick cuts. When the transversalis fascia is reached, its
ellow appearance evidences pus, and the peritoneum is
ked up with two hemostats and divided between them,
at underlying and adherent intestine is not injured. The
enlarged by blunt scissors, and a finger introduced. Pus
are readily ruptured unless great caution is employed. If
walls can be lifted by retractors, long sterile gauze bandages
ng tapes should be packed entirely around the diseased area
se off the peritoneal cavity and repress intruding intestines,
for the appendix is commenced. Great care is taken to
lastic exudate uniting coils of intestines. As rapidly as pus
mopped with dry aseptic gauze, not flushed. In children,
ribed abscess, an inexperienced operator will save more lives
ning the abscess and draining, than by searching for an ap-
may have sloughed and will obliterate itself.

not encountered and if the appendix is readily found in
below or curved around the cecum, it may be cautiously
n its tip, if intact (Fig. 82). The important guide in locat-
dix is the longitudinal band of the cecum at the lower ex-
ch will be found the base of the appendix (Fig. 83), providing
ve not already separated it. In loosening an appendix, any
he organ or on the cecum or intestines must be guarded. The
ent in searching for and removing the organ must depend
gment and the operative skill of the individual surgeon and
of the patient. One is tempted to do too much rather than
is wise to cease the efforts BEFORE, not AFTER the breaking
nveloping abscess walls. Perforations are more common at

the base than at the tip. In favorable cases, the mesappendix is ligated with chromicized gut and the appendix slowly loosened to its base. If tissues are sufficiently stable, a peritoneal cuff may be turned back upon the cecum, the base of the appendix crushed and ligated with chromicized gut. Gauze protection should be inserted before the tube is divided with scissors. The treatment of the stump will vary with the experience of the operator and the condition of the surrounding tissues. It may be cauter-

FIG. 82.—Tip of appendix firmly bound down by inflammatory adhesions (Int. Clinics, Bloodgood.)

ized or touched with a drop of pure carbolic acid. A purse-string suture of chromicized gut or silk or linen is then inserted in the cecum at the base, the stump seized with an inverter or with a pair of delicate slender forceps (Tait's needle forceps) and turned into the cecum while the purse-string is tied. If tissues permit, the site may be covered with peritoneum or with the mesappendix tissues, but this can only rarely be done if the operation has been delayed too long. The appendiceal artery and all bleeding vessels are examined and tied, since dangerous postoperative

hemorrhage has sometimes occurred. Other depots of pus may be cautiously sought by the finger. Many surgeons flush the wound, but diffusion of septic material is thereby made more probable; dry gauze sponging is safer. In pus cases drainage from appendix and pelvis must be free by split rubber and gauze strips within and outside the tubes. Glass tubes should never rest against a darkened cecum. If the appendix has been postcecal, drainage through an opening made by separating muscular fibres or by a stab wound through the loin or above the crest is best. The pri-

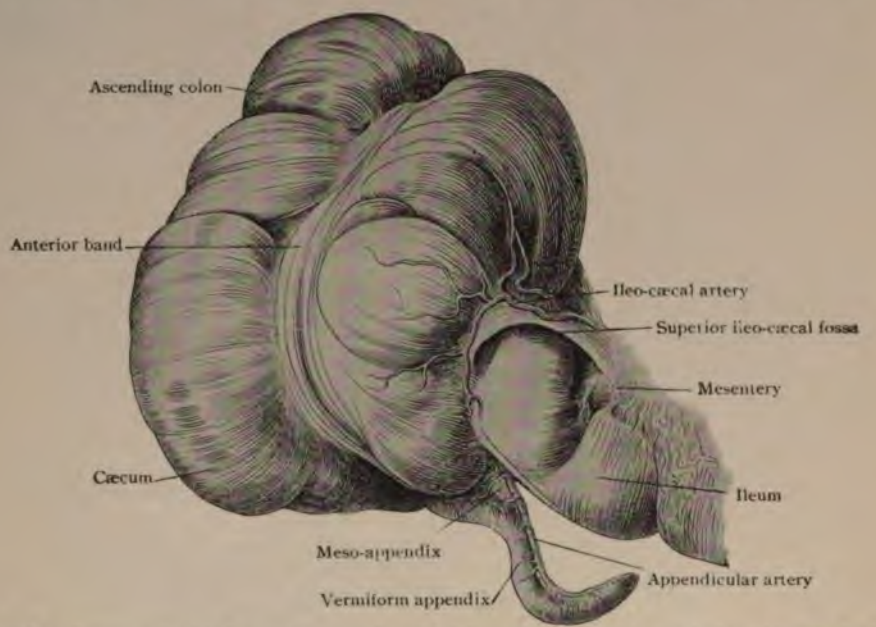


FIG. 83.—Cecum and related structures seen from the left; appendix found at end of cecal longitudinal band. (Piersol's Anatomy.)

mary circumferential packing is then removed, replaced by small strips if desirable, the intestines and the omentum arranged and the extremities of the wound closed. Drainage through displaced muscular fibre is less likely to be followed by hernia than through aponeurosis. If thorough drainage has been secured and symptoms favorable, the dressings should not be disturbed for several days, in order to give time for adhesions. They should then be removed by wetting with sterile saline solution and twisting to save pain. If the case is operated early, and no pus is found, the wound may be closed as in an interval operation (p. 128).

ACUTE SPREADING INFECTIOUS PERITONITIS.

When perforation or gangrene occurs and resistance is inactive, the protective wall is lacking and the infectious material may be quickly diffused over the entire peritoneum by peristaltic action, or by operative manipulations. The symptoms of collapse already described on page 117 will present to the surgeon an appalling picture. Two courses of action lie before him;

one the immediate free opening of the abdomen with rectal irrigation as urged by Murphy[1] or the starvation method of Ochsner (p. 121) designed to tide over the emergency and wait for later operation.

In children there can be but little question as to the course to be pursued on account of the anatomical and physical conditions already noted. Unfortunately the same obstacle holds good in either plan of treatment, *i.e.*, the patient must be old enough to coöperate with the surgeon in the details of treatment. Operative relief, therefore, seems to offer the best hope of success and should be employed in any case not absolutely moribund. In desperate cases the abdomen may be simply opened over the appendix under local anesthesia, tension relieved and large drainage inserted.

Murphy advocates the absolute prohibition of everything by the mouth to avoid peristalsis, the enforcing of the semi-sitting position from the inception of the attack, during removal to hospital and during and after operation, in order to confine the products to the pelvic area. The patient being on the table and entirely prepared for operation, nitrous oxide and ether are administered. The operation is completed in the speediest possible time,—"get in quickly; get out quicker,"—the appendix being simply ligated or let alone. Abundant drainage is secured with large fenestrated split rubber tubes inserted not only to the appendiceal region but into the vesicorectal pouch and other purulent areas. Cigarette drains are helpful. Washing and flushing the abdomen prolongs the operation and diffuses the poison.[2]

As the diaphragmatic region of the peritoneum most readily absorbs the dangerous toxic products, gravity is used to carry them to the more resistant pelvic area. The head of the bed should be raised from one to two feet. If the patient is raised to the sitting posture by pillows or bed chair he will constantly slide down, since the condition is one of such feebleness that voluntary efforts are impossible. A pillow supported by a folded sheet made into a sling beneath the buttocks and attached to the headboard on either side, will greatly assist; children can be best placed in a rocking chair or held continuously in the arms of a nurse.

Proctoclysis—Enteroclysis.—The continuous rectal administration of water is all-important if the child is tractable. A fountain syringe or glass jar filled with salt solution is fitted with $\frac{3}{8}$ inch rubber hose terminating in a hard rubber douche tip with multiple openings, flexed to a right angle to avoid rectal pressure. This tube is inserted well up in the rectum and held in position by adhesive strips to the thighs. The reservoir (preferably glass in order that the rate of flow may be watched) should be suspended just sufficiently high to balance intra-abdominal pressure, about six inches above the level of the anus, to permit drop by drop entrance, so that for several days in adolescents about one pint will enter in one or two hours. The tube is not removed from the rectum, but if leakage occurs the flow should be slackened and flatus allowed to escape. Failure usually occurs from the neglect of these rules. To be effective, this method needs a careful, watchful nurse. Proctoclysis reverses the stream through the lymph

[1] Murphy, Tr. Amer. Surg. Assoc., 1908, 47; Annals of Surgery, xlvii, 870, 1908.
[2] Kelly, Vermiform Appendix, 649.

channels into the peritoneum; the upright position causes the fluid to gravitate to the pelvis and an outward flow is induced. The heart and kidneys are stimulated, thirst relieved, blood-vessels filled, septic materials washed out, and dangers of phlebitis lessened. The aspect of the shrunken, livid, cold patient is often speedily changed to one of assured improvement. In former days the mortality in diffuse general infective peritonitis was from 50 to 65 per cent., while Murphy reports 37 recoveries in 38 consecutive cases, and later 51 cases with two deaths.[1] Fowler[2] reports 145 cases with 59 per cent. of recoveries and insists upon a small incision as essential to the non-escape of the bowels; thorough cleansing of the poisoning focus and removal of appendix, evacuation of all accessory

FIG. 84.—Double reservoir for maintaining temperature in rectal drop-by-drop enteroclysis (Saxon).

abscesses, flushing of the peritoneal cavity with hot saline solutions, free drainage with large glass tube with interior gauze strips, and elevation of the head and shoulders to carry drainage toward the pelvis.

In 1898 the mortality from diffuse spreading septic peritonitis was almost 100 per cent.

Saxon[3] points out the fact that the salt solution in a reservoir will become of the same temperature as that of the room in about half an hour, consequently a hot solution of 100 to 115 degrees cannot be maintained but must chill the patient. Also that the level of the fluid in a reservoir placed at a certain distance above the rectum is soon lowered so that if the hydrostatic pressure is only equal to that of intra-abdominal pressure

[1] Tr. Amer. Surg. Assoc., 1908, 128.

[2] Fowler, N. Y. State Journal of Medicine, Oct. 1907; Annals of Surgery, Dec., 1908, 828; N. Y. and Phil. Med. Jour., Nov. 19, 1904.

[3] Trans. Phil. Acad. of Surg., 1909.

the flow will cease. He has constructed a double pail, the inner reservoir jacketed by a chamber containing boiling water. The solution entering the rectum is controlled as to temperature by a thermometer near the anus, and the slow entrance of the fluid regulated (Fig. 84). A shunt-tube permits exit of flatus and fluids. A more expensive but satisfactory electrically heated appliance is shown in Fig. 85.

In toxic cases 1 to 20 c.c. of streptolytic serum may be injected at intervals with advantage.

FIG. 85.—Electrically heated proctoclysis apparatus for continuous flow. *A*, plug connection. *B*, heating tube. *C*, rectal tube. *D*, tube from reservoir.

INTERVAL OPERATION.

In an interval operation for chronic or recurrent appendicitis, and in all cases where pus is believed to be absent, or in the first twenty-four hours of acute cases, MUSCULAR FIBRE SEPARATION or the GRIDIRON method should be practised. The oblique incision commences above the line outside of the rectus joining the umbilicus and the anterior superior spinous process; the external oblique aponeurosis is divided and the fibres separated in the line of their course. The fibres of the internal oblique and transversalis are then separated in their respective directions, the layers being drawn apart with retractors. The transversalis fascia is divided, the peritoneum pinched up between two hemostats and nicked, caution being used not to injure any underlying and perhaps adherent intestine. A finger is then introduced, the meso-ileum and appendix located, and if no adhesions exist the wound is enlarged with blunt-pointed scissors. An inserted finger feels cautiously for any evidence of abscess or adhesions. In the simplest cases the appendix may be discovered and drawn out with a portion of the cecum through a small opening. In many cases if the appendix is bound by old strong adhesions, the wound must be enlarged and the bands cautiously separated. When the organ is freed from adhesions, the mesappendix is ligated to its base with chromicized gut, then severed, and a serous cuff turned back from the appendix upon the cecum. The appendix is then clamped and crushed and a chromicized gut

re tied about the bared tube. Carefully surrounding the area
he appendix is divided with scissors and the cautery or pure
applied to the stump. Before division a purse-string suture,
gut or silk or linen is carried around the base. The stump
ith tiny slender forceps and inverted into the cecum while
ing is tied (p. 123). The indentation is then covered with
peritoneum or with stump of the mesappendix, the parts re-
abdomen, and intestines and omentum arranged. The peri-
toneum is closed with continuous catgut sutures, the separated muscular fibres brought back to original positions and sutured, and the fascia and skin likewise closed. With such an aseptic operation, the chances of hernia or of a fatal termination are practically nil. In girls the pelvic organs should always be examined and other organs also if

ith flat rubber pad to support
appendectomy. (Willis.)

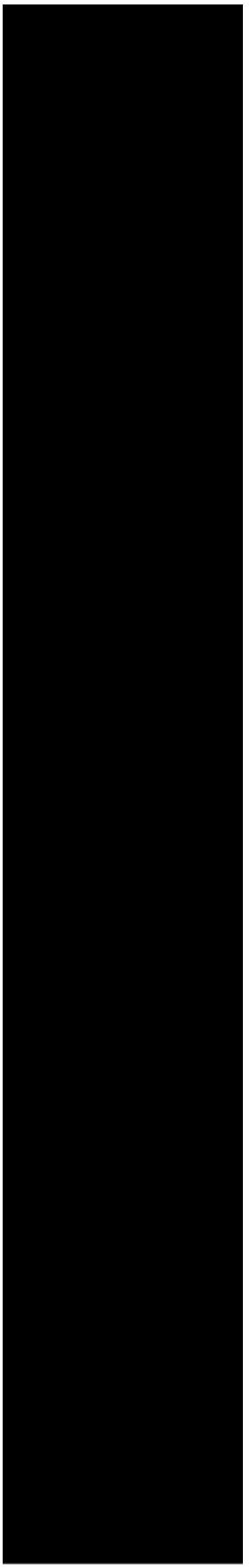
spected. In girls, a silver wire intracuticular skin suture is
avoid scar. Some operators make a strong resultant abdom-
incising at the outer edge of the rectus muscle, retracting the
l the median line, and dividing the posterior sheath in such
the incision lines shall be upon different planes.

valescence after the day following an interval operation is
entful and rapid. The aseptic dressings should not be dis-
the seventh day when the stitches are removed. While the
be healed in this time
will not be strong, and
ildren the longer they
to bed, the less acci-
e encountered. Three
e too long for safety.
ary measure for six
year in athletic boys is
ng truss with large flat
covering the cicatrix
an abdominal support

Fig. 87.—Abdominal bandage for support of lower abdomen after appendectomy. (Storm.)

eatment of Pus Cases.—
ases, even when the
peritonitis are not as
s those described on page 117, slow drop-by-drop rectal
(Fig. 84, p. 126) is advisable in adolescents, together with the
d position for the purpose of securing better drainage from
rtion of the peritoneal cavity which is the region best suited
septic products. Gauze drainage should be removed early.
t rubber tubes should be used when there is any risk of
he cecum or intestine. Irrigation may drive septic particles
oneum. Water may be given if there is no vomiting. Food
ithheld as much as possible to avoid peristalsis, the rectum

FIG. 88.—Fecal fistulæ after appendectomy. (Coffey.) *A*, simplest form; *B*, spur formation reducible; *C*, artificial anus; *D*, fistula from remote cavity; *E*, large gangrenous cavity; *F*, cancerous.



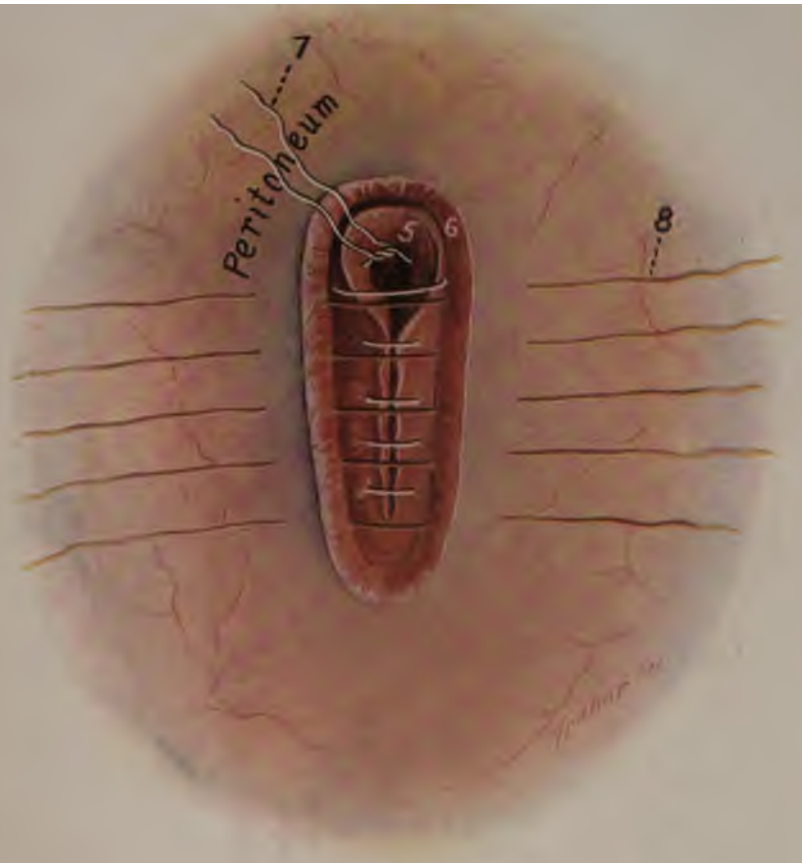


FIG. 89.—Fecal fistula; closure of opening with supplementary inturning sutures. (Coffey.) 7, sutures closing fistula; 8, inturning sutures.

being used for medicine and for concentrated nutrient injections. The passage of flatus should be encouraged; a catheter occasionally carried into the rectum gives much comfort. The bowels should remain quiet for four days and then be very gently encouraged by calomel, followed by salines and enemata. Perfect rest of body and mind should be sought and stimulation applied as necessary. Young children may require bromides and paregoric; older ones $\frac{1}{64}$ or $\frac{1}{32}$ of morphia at night. Persistent vomiting is best controlled in young children by dry calomel on the tongue without sugar or soda; in older children by lavage.

REMARKS.—By lifting a nonadherent abdominal wall, safe packing of the peritoneal cavity and intruding intestines is facilitated. The strip of gauze within the drain tube of either glass or rubber removes the pus by capillarity, consequently should not fit tightly. A small gray gangrenous spot on the cecum or intestines may be inverted and sutured. Fecal fistulæ (Fig. 88) usually close spontaneously if not interfered with by mischievous probing and packing. Their depth and extent may be determined by injecting bismuth and petrolatum and employing the X-ray. If finally persistent after curetting, paring, cautery, etc., they may be closed by secondary operation[1] (Fig. 89). In late operations, if the appendix has sloughed and is missing, efforts to do a complete operation will break through the abscess wall. Search for the appendix must depend upon the judgment and skill of the operator. If the appendix has sloughed, the permeability of the lumen should be determined by probe, before it is inverted into the cecum. The condition of the tissues in each individual case will determine the method of treatment of the stump. The stump can sometimes be covered by tying together the ends of the purse-string and of the mesappendix ligature. If the primary opening has been made in the semilunar line, and the pus has been found far back, it is wiser to close the primary wound and drain by separating muscular fibres or by a stab wound through the loin or above the iliac crest. If large muscular division has been necessitated, the fibres should be sutured to prevent subsequent bulging of walls.

Adhesions and bands may in the second or third week give rise to symptoms of intestinal obstruction or of volvulus, and demand a second operation. Undiscovered and secondary collections of pus in any portion of the abdomen also demand operative relief.

Repeated infections of the appendix not operated upon will result in a large dense tumor that may be mistaken for sarcoma, even during a later exploratory operation. Tuberculosis and cancer are not common in childhood.

Atony of the bowel may be relieved by eserine and by turpentine enemata or by physostigmin salicylate.

Great comfort will be secured after ordinary operations by placing a pillow beneath the lumbar region or by turning the patient frequently upon the right side to save the pelvis from infection. Postoperative vomiting is best relieved by lavage before the patient leaves the table; later, by large draughts of warm water. Small sips of cool water are more grateful than cracked ice; the latter leaves a hot mouth.

The experience of the author is decidedly against wiping the intestines, or bruising the peritoneum, or flushing; pus is safer absorbed by dry gauze.

[1] Coffey, Annals of Surgery, June, 1907, xlv, 827.

SUMMARY.

lren even a reasonably sure diagnosis of acute appendicitis
tion in the first twenty-four hours while the lumen is intact.
tive and gangrenous cases are not as likely to be circum-
lren as in adults.
ıus spreading peritonitis is especially fatal in children and
ediate rapid operation, free drainage, the sitting position
ɛr operation and slow rectal irrigation. If the latter is not
ıemata may be given.
inite attack of appendicitis has become quiescent, the organ
ɔved, as the second infection may prove serious or fatal.
ɛnt attacks, even if catarrhal, demand removal in the inter-
ration is far safer than the retention of the diseased organ.
ırvation and lavage treatment advocated by Ochsner is the
of preventing peristaltic diffusion of the infection if the child
o coöperate with the surgeon.
purative and perforative cases, the inexperienced surgeon
by simply opening the abscess and refraining from search for

ɔ and recurrent cases invalid the patient and make life miser-
ı unfortunate condition could have been prevented by early
any obscure symptoms will disappear after an interval ope-

ınd interval operations are simple and safe; late ones, compli-
gerous.

HERNIA, ABDOMINAL.

Synonym: Rupture through abdominal wall.

ion of some portion of the abdominal contents is not un-
, and such protrusion may take place at any later period of
ms are denominated CONGENITAL, INFANTILE, ACQUIRED,
IC hernia. The different varieties, INGUINAL, FEMORAL,
c., take their names from the region in which they occur.
l **hernia** is especially common at the inguinal openings and
us; femoral hernia is rare before puberty. Inguinal hernia
in connection with the round ligament in the canal of Nuck.
hernia may be produced suddenly by crying or by accident,
the pushing forward of a process of peritoneum or by the
wing down an unclosed canal. An infantile hernia, there-
congenital even though it is not evident at birth.
l **Inguinal Hernia.**—The occurrence of the inguinal variety
s is easily explained. During the early months of fetal life,
es behind the peritoneum in the lumbar region below the
developmental stages are well illustrated by the accompany-

rst weeks of embryonic life an anterior bud protrudes from
velling which later becomes either a scrotum or a labium.
he fifth week, the indifferent stage of sexual development

from the WOLFFIAN and MÜLLERIAN DUCTS is succeeded by the appearance of testicular development below the kidney. By the sixth week projections from the Wolffian tubules to form the testes are noticeable, and the Wolffian bodies begin to atrophy. About the third month a slender band, the GUBERNACULUM TESTIS, is formed extending upward from the scrotum through the inguinal canal to the intra-abdominal testicle and later forms the condensed SCROTAL LIGAMENT. The peritoneum now closes around the testicle and gubernaculum, forming the MESORCHIUM and extending downward as a tube to the inguinal ring forms the VAGINAL PROCESS of the PERITONEUM. The mesentery of the testis lengthens and migratory descent begins in the second month. Guided by the GENITO-INGUINAL LIGAMENT[1] it reaches the internal abdominal ring region by the end of the third month, where it is detained by the CONUS INGUALIS until the end of the sixth month. At the seventh month the inguinal bursa deepens, the peritoneal PROCESSUS VAGINALIS and the testicle descend through the inguinal canal, coaxed by the shortening of the genito-inguinal ligament from its attachment at the base of the scrotum, and by the cremasteric fibres. The testis drawn from its mesentery (MESORCHIUM) descends behind and outside the peritoneal pouch, the lower portion of which later becomes the tunica vaginalis testis (Fig. 90). At the eighth month the testicle has reached or passed the external ring. As soon as the testis has been lodged in the scrotum in the last month of pregnancy, a process of obliteration begins slowly shutting off the tubular vaginal process at the internal abdominal ring. This obliteration extends downward until the lower portion is separated and forms a closed sac. The obliterated structure is known as the FUNICULAR PROCESS; the serous sac enveloping the testicle as the TUNICA VAGINALIS TESTIS (Fig. 91).

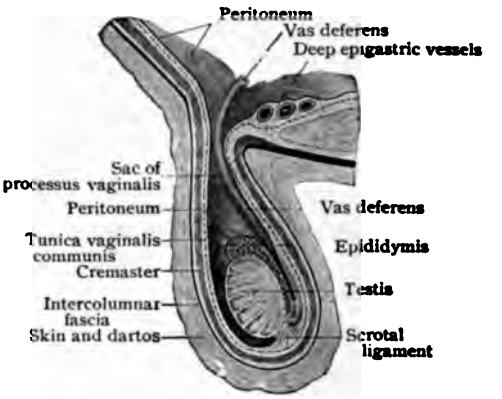


FIG. 90. — Diagram showing relations of descended testicle to processus vaginalis, which still freely communicates with peritoneal sac of abdomen (after Waldeyer). (Piersol's Anatomy.)

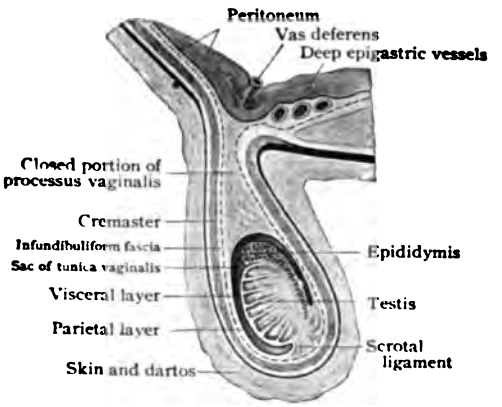


FIG. 91. — Diagram showing relations of testicle to serous membrane after upper part of processus vaginalis has closed, its lower part persisting as tunica vaginalis. (Piersol's Anatomy.)

[1] Piersol's Anatomy, 2040.

In congenital inguinal hernia this closure fails to take place and the tube remains open from the general peritoneal cavity at the internal ring to the testicle, thus permitting the ready entrance of an intestine into the lower portion. If this closure fails to take place, the testicle remains in connection with the peritoneal cavity and a loop of bowel may easily make its way down the lumen—a funicular hernia (Fig. 92.) If complete obliteration occurs, as in the normal, a canal no longer exists, but the space is filled with the spermatic cord, the vessels, nerves, vas deferens, and the condensed gubernaculum testis—the scrotal ligament. In young girls, the inguinal variety is more common than the femoral, as the imperfectly closed canal of Nuck invites protrusion and the femoral canal is small. In females after puberty, the widening of the pelvis renders the crural arch less able to resist the intra-abdominal pressure of child-bearing and femoral hernia results, with escape of the intestine at the saphenous opening.

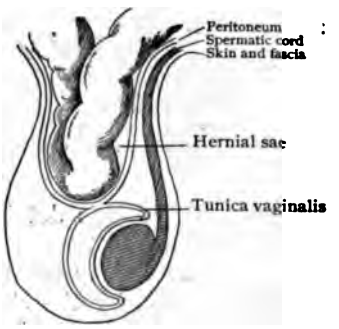


FIG. 92.—Diagram of funicular hernia, showing relation of hernial sac to tunica vaginalis. (Piersol's Anatomy.)

FIG. 93.—Diagram of so-called encysted hernia, showing supposed relation of hernial sac to peritoneum. (Piersol's Anatomy.)

Acquired infantile hernia differs from the above from the fact that obliterat on of the pouch has occurred at the internal inguinal ring, but not throughout the rest of the vaginal process. An intestine to reach the scrotum must therefore push before it a new peritoneal sac. Should the yielding permit the gut to follow down the original tube, an ENCYSTED HERNIA (Fig. 93) results, the hernial sac being within the tunica vaginalis, while in INFANTILE HERNIA (Fig. 94) the sac is in front or behind this membrane. In congenital hernia, the intestine lies in this cavity with no other peritoneal coats, the intestine having descended into an original sac (Fig. 95). The hernia may not exist at birth, but if the canal is open it facilitates subsequent prolapse—a CONGENITAL SAC WITH AN ACQUIRED HERNIA.

Still another form of hernia is produced when an intestine makes its way down a vaginal process that has been partially obliterated, just sufficient to shut off the testicular sac—a PARTIAL FUNICULAR HERNIA. In a normal closure of the funicular process after the passage of the testicle or round ligament, buttress fibres of connective tissue close about the cord both at external and internal ring, but dimples or depressions still remain in the peritoneal fossa, inviting the insinuation of an intestine or omentum at all periods of life. An ACQUIRED HERNIA can thus be formed by push-

ing down a peritoneal sac either suddenly from strain or by traumatism, or slowly at any age. Frequently it follows the original congenital inguinal canal. Acquired hernia in infants is often due to whooping-cough, continued crying from indigestion, coughing, elongated uvula, constipation, contracted prepuce, vesical calculus, or from any increased intra-abdominal pressure. Heredity also is a cause both in congenital or acquired forms, from relaxation of tissues. Rough sports or lifting or an accident are frequent causes in larger boys, especially if a long mesentery exists.[1]

The OBLIQUE INGUINAL variety is the form usually found in childhood, principally of course in boys, as the inguinal canal is short. The omentum is so short in children that an EPIPLOCELE is rare. The appendix or cecum, or the convex surface of the gut (Richter's) or a Meckel's diverticulum (Littré's) are only rarely found in the sac. IRREDUCIBLE hernia is rare in children, unless it is cecal. The other varieties of hernia, *ventral*, *sciatic*,

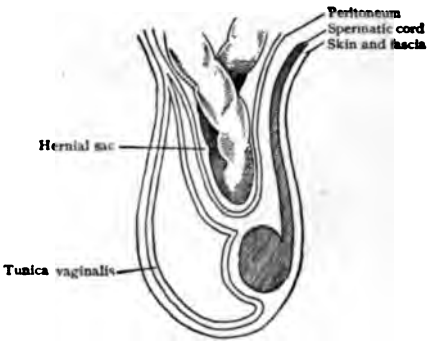


FIG. 94.—Diagram of infantile hernia, showing relation of hernial sac to tunica vaginalis. (Piersol's Anatomy.)

FIG. 95.—Diagram of congenital hernia, showing relation of hernial sac to peritoneum. (Piersol's Anatomy.)

lumbar, *diaphragmatic*, etc., occur only rarely. Internal strangulation of a loop of intestine passing through a fold of omentum or entering the internal ring is not common.

The coverings of a true inguinal hernia are, (1) peritoneum; (2) infundibuliform or transversalis fascia; (3) cremasteric fibres from the transversalis and internal oblique; (4) intercolumnar fascia, external oblique; (5) superficial fascia and skin (Fig. 96).

In girls the ovary remains in the pelvis, while the genito-inguinal ligament becomes the round ligament of the uterus and is attached subcutaneously in the mons and labium major. The peritoneal pouch may persist as the canal of Nuck and in this canal, CONGENITAL and INFANTILE hernia and also HYDROCELE of the cord may occur.

Causes.—The causes of hernia are CONGENITAL, PREDISPOSING, and EXCITING. Developmental weakness of structures is the cause of the congenital and infantile varieties. The predisposing causes are an elongated mesentery, sex, occupation, age, muscular insufficiency, heredity. The exciting causes are traumatism, intra-abdominal pressure, crying, coughing, straining, calculus, etc.

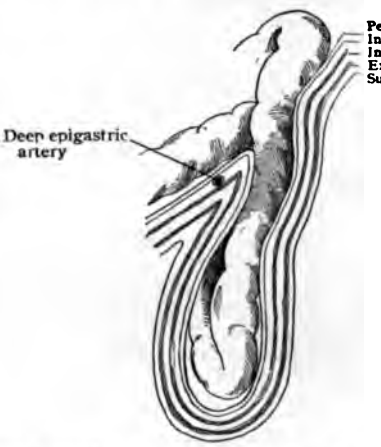
[1] Willard, Surgery of Infants, Phila. Med. Times, xv, 785.

e children are ruptured in proportion to one female from the asons already given.

of all hernias occur before the age of fourteen; thirty per occur during the first year; 10 per cent. in females.

gives the percentage of hernias, as males, inguinal, 83.5 per , inguinal, 8.5 per cent.; males, femoral, 2.1 per cent.; females, per cent. In later life, 1 male in 15 or 20 has hernia; in 50. In the War of the Rebellion, the recruits rejected for 4 per 1000; of native born, 31 per 1000.

al Diagnosis.—In the scrotum, or at the outer region of the he inguinal canal above the groin, a tumor that enlarges and lse when the child cries or is placed erect, and recedes sudslip or gurgle on lying down or on gentle pressure, is presumnal hernia. In girls, the tumor over the canal of Nuck will



m showing coverings of complete left indirect inguinal hernia. (Piersol's Anatomy.)

s a congenital hydrocele with open vaginal process permits fluid contents into the abdomen without the sudden collapse rs in a hernia. The two conditions, however, may coexist. n of a hydrocele during crying is less than that of a hernia. ginal process of the peritoneum in boys is pervious as far as ring it resembles the funicular variety of congenital hydroed hydrocele of the cord will give a rounded tumor, nonhe diagnosis before operation is sometimes difficult.[1]

Hernia	Congenital Hydrocele
e by manipulation, or by ent position rs suddenly, sometimes urgling sound	*Recedes slowly and silently.*
anslucent	*Is translucent.*

Phila. Polyclinic, iii, 90; Phila. Med. News, lxii, 454, and xlv, 219; Trans. ., v, 62 and vi, 19.

A true hydrocele, or collection of serum in the normal separated enveloping sac of the testis, tunica vaginalis testis, does not recede under pressure.

Hernia	Hydrocele
Impulse on coughing or straining	*No impulse.*
Reducible	*Non-reducible.*
Opaque	*Translucent, unless blood is present.*
Tumor hangs from body	*Tumor pyriform and stands out from body as though hinged at base.*
Elastic or doughy	*Tense and rounded.*
Cord obliterated	*Cord can be felt above the hydrocele.*
Initial tumor first noticed at top of scrotum	*Initial tumor develops below and fills upward.*

Undescended Testicle.—An ectopic testis is not an infrequent accompaniment of a congenital hernia. Its absence from the scrotum and the presence of a tumor in the canal will indicate the condition.

Hernia	Undescended Testicle
Testicle in scrotum	*Testicle absent or in canal.*
Elastic tumor, painless on pressure unless strangulated	*Rounded firm tumor in canal; site of testicle sensitive.*

Psoas Abscess.—A psoas or iliac abscess may recede under pressure during recumbency but imparts a sensation of expansion rather than of succussion under coughing. The history also of spinal caries or of iliac inflammation is obtainable.

Hernia	Psoas Abscess
Tumor appears at base of scrotum and is reducible on lying	*Tumor farther out under Poupart's ligament. Can be traced up into iliac fossa. Non-reducible.*
Impulse on coughing	*Impulse slight.*
Soft and doughy	*Fluctuating.*
No bone disease	*Evidence of spinal or iliac caries.*

Varicocele.—In adolescents a varicocele is usually situated on the left side.

Inguinal Hernia	Varicocele
Crying and straining give an impulse	*Faint impulse.*
Is round, elastic or doughy	*Irregular in shape; tortuous veins palpable.*
When reduced in the recumbent position, the swelling, on rising, reappears at the top of the scrotum and slowly descends	*On rising, swelling slowly fills from bottom of scrotum upward.*
When reduced in recumbent position, a finger placed over external ring will prevent exit on rising and during coughing or straining	*A finger placed with moderate pressure over external ring will permit swelling to quickly appear on rising.*
Skin normal	*Tortuous veins showing beneath.*

Both swellings appear in the erect and disappear in the recumbent position.

Appendicitis.—An unrecognized right inguinal hernia becoming pinched or partially strangulated will give symptoms of pain, vomiting,

tenderness and rigidity, and only the discovery of the tumor will decide the question between hernia and appendicitis. Operation is indicated in either condition; if no trouble is found in the appendix, the internal rings should always be examined. The presence of an appendix or a cecum in a hernial pouch may be the source of a true appendicitis. In operating for hernia the author recalls having only occasionally found an appendix in the sac; the presence of the cecum is more common.

ENLARGED LYMPHATIC GLANDS.—Enlarged glands may overlie a hernia, and if suppurative from infection may give a doughy tumor with impulse or fluctuation.

BUBONOCELE.—An incomplete hernia lying in the inguinal canal in large boys must be differentiated from specific bubo. Hernias have been laid open under such false diagnosis. A bubonic abscess will be irreducible.[1] ORCHITIS and EPIDIDYMITIS will usually be traumatic or specific. LIPOMA and LYMPHANGIOMA are rare.

Prognosis.—Statistics show that many hernias occurring even later in life are due to non-obliteration of the peritoneal process and imperfect closure of this canal. A cure may occur from shortening of the mesentery during growth. Spontaneous closure occurs after birth in many cases, and with proper treatment with trusses nearly three-fourths of these ruptures can be cured before the age of six. Under twelve years of age operative interference is required only in cases enumerated on page 139.

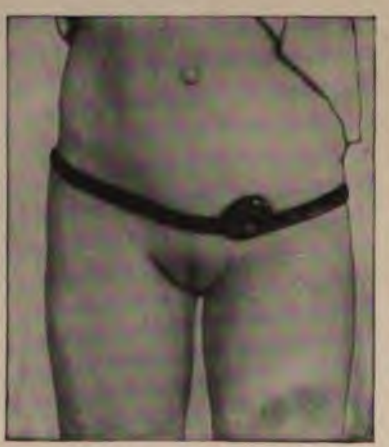


FIG. 97.—Cross-body hard-rubber truss as usually applied without perineal understrap. (De Garmo, Abdominal Hernia.)

PROGNOSIS OF RADICAL OPERATION.—In Coley's statistics[2] of over 2000 operations by Bassini's method with kangaroo tendon or by suture of the canal without transplantation of the cord, the mortality was one half of 1 per cent. Over 95 per cent. were cured. The youngest case was thirteen days old (recovery after strangulation); 837 cases of inguinal hernia were traced (one fourteen years after operation) and found in sound condition, with only 1 per cent. of relapses.

An exomphalic hernia has been successfully operated when three hours old. The extremes of age of successful operation by the author for strangulated hernia have been one year and ninety-five years. In omphalocele he has operated on the second day of life (p. 155).

Treatment.—In congenital and infantile hernias, and in fact in all hernial cases, much can be accomplished in facilitating closure of the sac by preventing the WEDGE ACTION of the bowel in the canal. LOWERING OF ABDOMINAL PRESSURE may be accomplished by careful correction of digestive troubles, of gaseous distentions and constipation, thus preventing crying and straining. Regular, systematic feeding will also accomplish

[1] Kirmisson, Précis de Chir. Inf., 160.

[2] Jour. Amer. Med. Assoc., Sept. 21, 1907; Keen's Surgery, iv, 35, 77.

much. A crying child can often be better satisfied with cool boiled water than with milk. Coughing should be prevented as much as possible, especially in whooping-cough, in which disease a cresoline lamp burning at night is helpful.

The child should sleep with head low. In severe ruptures, where a truss fails to restrain the hernia and operation is refused, attention to the above precautions and ABSOLUTE CONFINEMENT IN BED in the dorsal position FOR SIX WEEKS will sometimes effect closure. An adherent prepuce should be stripped. A contracted prepuce may be circumcised (p. 201) although Hebrew boys are as subject to hernia as are others. A stone in the bladder should be removed (p. 209).

FIG. 98.—Properly adjusted De Garmo-Hood truss retaining hernia within abdomen and with thin pad for support of opposite side. (De Garmo, Abdominal Hernia.)

TRUSSES.—In the majority of congenital infantile and inguinal hernias, cure can be obtained by a well-fitting truss applied night and day for several years. The probability of truss cure diminishes each year up to the age of puberty, after which time secure closure of the canal is very improbable without operation. Trusses in infants with inguinal hernia should be of material that can be frequently changed and washed. A temporary support can be made for the first few weeks of life by a thick folded skein of Berlin wool.[1] The loop end is applied over the emptied canal the two free ends being carried above the pubes across the abdomen, around the loins and back, over the hip of the hernial side, through the loop, around the inner side of the thigh and over the buttock to be secured to the skein above the great trochanter. This can be washed while another skein is similarly applied.

A spring truss with vulcanized pad (Fig. 97) or air or aluminum pad is more certain in active children, especially after the first few weeks, and

[1] Owen, Surg. Diseases of Children, 347, 1897.

is more readily cleansed. For cleanliness two trusses are desirable. They should be washed frequently and the underlying skin bathed, then sponged with alcohol and alum and dusted with stearate of zinc. A layer of salicylated or borated gauze worn beneath the pad for the first few weeks and frequently changed, will prevent excoriation. A truss should be worn for at least two years AFTER a cure is believed to have been effected.

In measuring for a truss the child should lie upon his back and the circumference of the pelvis taken above the trochanters. The truss must be applied with the child in the supine position and with hernia reduced. If he is moved for cleansing while without the truss the inguinal canal should be supported by the finger of the nurse. The pad

FIG. 99.—Typical illustration of a badly fitted truss with a French-German appliance, frequently seen. Note that the pad acts as a compress directly over the pubic bone, and that the hernia is in the canal above. (De Garmo, Abdominal Hernia.)

should fit over the internal ring and canal above the line of the pubic bone, (Fig. 98) not in the groin crease (Fig. 99). The spring arch should pass around the pelvis on the side opposite the hernia.

In older children the hard-rubber trusses are usually more serviceable, are more readily kept clean, permit swimming, and will withstand perspiration. The spring should be weak and must be changed and altered (Fig. 100) with the growth of the child. If the hernia is not retained in place but slips beneath the pad, the pressure may convert a reducible hernia into an irreducible one. A truss placed over an irreducible hernia is both painful and dangerous, and operation is indicated.

INJECTIONS.—White oak bark or alcohol or paraffin injections are unsafe, as it is impossible to accurately place them without danger of entering the sac.

Indications for Radical Operation.—In infants a radical operation is demanded only when, in addition to correction of all causes of intra-ab-

dominal pressure together with rest in bed, various forms of trusses have been faithfully tried and have failed, or when constant crying drives the bowel down in spite of every precaution, giving the risk of strangulation. It is also justifiable when the parents are too careless or ignorant to maintain the adjustment of a truss properly, or when digestive troubles are persistent. In children under twelve and especially under six, a truss with proper care will often produce closure of the canal, but in certain cases an operation is better, particularly when the rupture is complicated with an undescended testicle (p. 214) or when strangulation occurs. The necessity for operation depends not so much upon the age of the child as upon the controlability of the rupture and the personal surroundings. Early operation is indicated when a child lives in a region distant from surgical help and for feeble-minded or careless boys. A truss cure is less certain of permanency than an operative cure. The author recalls a patient in whom a congenital hernia was closed by truss in two years; it recurred at six and was again closed by truss, but at fifteen it returned and was cured by operation. Irreducible hernia with adhesions requires operation. A very large opening which shows no tendency to close, but by continually pinching the bowel provokes much crying, is also an indication for operative relief.

FIG. 100.—Shaping truss springs by heat. (De Garmo, Hernia.)

After twelve in active boys, particularly in those obliged to earn their living, radical cure should be employed, as otherwise a truss must be worn for life, with constant danger of strangulation, with increase of insurance risk, and prohibition from public service. The slight risks of the operation are less than the dangers from strangulation. In girls, unless the canal of Nuck closes early with truss pressure, an operation is advisable, especially after puberty, to prevent the risks of strangulation.

Preparation for Operation.—When possible, the child should be confined to bed for several days in advance in order that it may become accustomed to confinement and may cease crying. The bowels should be thoroughly emptied each day with castor oil, and food restricted and limited to materials that produce little fecal matter. Chloroform is less liable than ether to produce sub-

sequent vomiting, but is more dangerous. Local anesthesia may be used in adolescents (p. 21).

Radical Operation.—In infants, displacement of the cord is generally unnecessary. After thoroughly cleansing the area and rendering it aseptic, the aponeurosis of the external oblique is slit to a point beyond the internal ring. The isolation of the sac from the cord requires great caution. The sac is opened to be certain as to identity and emptiness and traced well back beyond the internal ring. An anchoring double ligature is carried through the sac to prevent slipping and the neck tied firmly but not tightly with chromicized gut or fine kangaroo tendon. The sac is then removed and the aponeurosis closed with a single row of fine kangaroo sutures WITHOUT DISPLACING THE CORD. The skin and connective tissue should be closed with iodinized gut sutures without drainage. The wound

FIG. 101.—Internal oblique sutured to Poupart's ligament by catgut. (Halsted.)

is dressed with cotton, thymol di-iodide and collodion and a light plaster-of-Paris bandage applied to pelvis and thigh. This cast can be coated with shellac, and with care in the arrangement of absorbent cotton and rubber tissue between the wound and the urethra, soiling of the wound can be prevented. Rubber tissue can be fastened to the cast and to the skin with adhesive plaster or collodion and the penis passed through a small opening. In older boys under twelve, it is also seldom necessary to displace the cord but, after ligating the sac, the conjoined tendon of internal oblique and transversalis muscles is sutured to Poupart's ligament (Fig. 101), and the external oblique aponeurosis united by a second row of kangaroo tendon sutures,—interrupted or mattress or overlapping,—according to the judgment of the operator. In all ligations of the sac, the cincture should be applied as high as possible and a finger or blunt instrument inserted in the sac to be certain that the intestine is not included. Care should be taken in tying sutures that muscular fibres are not constricted.

For boys over twelve, the Bassini, or one of its many modifications, offers abundant hope of permanent cure without relapse.[1]

Technic.—Under general or local anesthesia and with strict asepsis, the aponeurosis is exposed by a long incision half an inch above and parallel to Poupart's ligament. The inguinal canal is slit on a grooved director its entire length and well above the internal ring. The upper flap of aponeurosis is dissected back with the handle of the scalpel or with a pad of gauze as far as the border of the rectus muscle and the lower aponeurosis is loosened to Poupart's ligament. These flaps are held aside by retractors or by traction sutures. Then with knife, blunt scissors and forceps the sac is separated from the spermatic cord without disturbing tissues more than necessary. When in doubt this sac is opened to ascertain its character, its course, and its freedom from intestine. The cord is thor-

FIG. 102.—Bassini operation. Isolation and ligation of the sac. (Coley, Keen.)

FIG. 103.—Bassini operation. Deep sutures, showing suture above cord. (Coley, Keen.)

oughly cleared well up beyond the internal abdominal ring, the loosened open mouth of the sac being grasped with four forceps and drawn well out from the abdomen (Fig. 102). The neck of the sac is transfixed with a chromicized double ligature, which is tied both ways and then circumferentially, while a finger or blunt instrument pushes the intestine well back into the abdominal cavity. The ligated sac is drawn down and cut away so that it will retract within the abdomen and OBLITERATE THE DEPRESSION, allowing no peritoneal pouch to remain to invite future entrance of intestine. The cord is next lifted from its bed with a strip of gauze and three to five kangaroo-tendon sutures are introduced on a curved needle into the conjoined tendon and internal oblique and transversalis fibres. These sutures are carried BEHIND the cord and attached to Poupart's ligament (Fig. 103), being careful to avoid THE FEMORAL VESSELS BENEATH. The needle is passed more safely from beneath upward. The suture above and below the cord at the internal ring and the one at the base of the scrotum

[1] Coley, Keen's Surgery, iv, 67.

rmly but not constrict the vessels or vas. The suture above
ing will of course pass in front of the cord, not behind it.
w arranged in its new and more superficial position and the
ue aponeurosis sutured continuously over it with kangaroo
gut. The skin and connective tissue are closed with catgut,
racuticular suture, or horsehair chain. The former is de-
able with young children. Thymol di-iodide, cotton, collo-
septic dressing will be followed by speedy union, if the boy is
a light plaster bandage encircling pelvis and thigh.

TING UNDESCENDED TESTICLE may be brought down into
r removed (p. 215). Such an ectopic testis rarely secretes
and for cosmetic purposes a celluloid one answers every

atment.—Water may be given freely, but food should be
the bowels moved cautiously on the third and each succeed-
foot of the bed should be raised. The dressings should not
or ten days. As non-relapse is the essential purpose of the
much time cannot be given in active boys to the strength-
icatrix and the longer they are confined in bed the better.
a truss with a flat pad worn for six months will support the
an a rounded pad and not make injurious pressure on the
it acts daily as a cautionary reminder.

ns.—Separation of the sac from the cord in children is often
e and troublesome process and is often impossible except by
anal and tracing it backward. As the sac is thin, it is liable
separating it from the cord. The deep epigastric, as well as
essels should be avoided. Bleeding should be entirely con-
sion or ligature before closing the wound as oozing into the
ve tissue will delay healing. Care should be taken not to
as deferens in ligation of the sac at the internal ring. If
uld be telescoped and sutured.

ion ligature at the neck of the sac obviates the necessity for
prevent slipping. Stitches must not be drawn so tightly as
tissues. Rubber gloves, strict asepsis, absorbable sutures
e of unnecessary manipulations of tissues are all important.
tendon and chromicized gut must be absolutely sterile and
thoroughly reliable firm. Deaver folds the sac upon itself
t to the abdominal wall at the site of the internal ring.
ates the intraperitoneal transplantation of the cord and the
the internal ring.[1]

genital hernia with open vaginal process, the serous mem-
ed and the lower portion sutured around the testicle to form
alis; the upper portion is tied and removed. In a CONGEN-
rnia, the absence of the normal serous covering will be con-
also a PROPERITONEAL hernia between the transversalis
itoneum, especially when associated with undescended tes-
phimosis with contracted prepuce, circumcision may be done

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tions of Coley, Fowler, Kocher, Macewen, Halsted, Bloodgood, Ferguson,
e found described in Bryant's, Binnie's and other Operative Surgeries.

at operation; in false phimosis the adherent prepuce should be stripped from the glans. If vesical symptoms exist, the bladder should be sounded.

Strangulation.—Strangulation is rare in childhood but occasionally occurs even in infants. Estoer[1] has collected 225 cases, with a mortality after operation about similar to that of adults. In an infant with inguinal hernia, any pinching of the bowel will arouse crying and a diagnosis from coincident appendicitis is difficult, as pain, vomiting, localized tenderness and rigidity will be present in both conditions. The presence of the tumor in the canal or scrotum or canal of Nuck is distinctive, unless an appendix lies in the sac. In intussusception, bloody stools are present. Internal strangulation may occur from a band or from a Meckel's diverticulum, without any visible tumor. In older children the symptoms of strangulation will be similar to those met with in adults. Hydrocele of the cord has been mistaken for strangulated hernia in infants; the mother may be mistaken in stating that the tumor appeared suddenly. In hydrocele there will be the absence of pain unless colic is present; the temperature will be normal, vomiting and constipation will be absent.

TAXIS.—Manipulative procedures for reduction of a retained hernial protrusion consist, after anesthetization, in loosening and guiding the intestine at the external abdominal ring with the thumb and fingers of one hand, while with the other the intestine is first drawn DOWNWARD to elongate and efface the folds that may have formed about the fascial edges of the ring. Reduction efforts are then made by slowly compressing the sac and making pressure upward, outward and backward in the line of the canal.

Preliminary to operation the foot of the bed should be raised and a shoulder sling so arranged that the child lies inverted. An ice-bag may be applied locally. If previous manipulations have been made, gentle taxis should never be continued for more than five minutes and only after preparations have been made for immediate operation, since gangrene occurs early and the bowel may be ruptured or septic material introduced into the peritoneal cavity. In large boys, self manipulation of a hernia is sometimes more effective than the taxis of the surgeon.

HERNIOTOMY, OR KELOTOMY.—If taxis fails, open operation should be done at once. The technic of the operation for strangulation will not practically differ from the same procedure in adults and need not here be emphasized except to advocate early and quick relief. The saving of patients with strangulated hernia depends upon early diagnosis, the minimum of injury from taxis and prompt operation to avoid gangrene.[2] The author recalls being called in consultation to a patient who had been treated for days for the vomiting of gastritis (!) without any examination of the abdomen, and in whom spontaneous perforation of the abdominal walls had already taken place from gangrene of the intestine. In stercoraceous vomiting, lavage, both before and after operation, should be performed to prevent septic pneumonia. After strangulation and radical operation, a child should be kept in bed for six weeks.

In the hernial sac may lie an ovary which if the pedicle becomes twisted will present the symptoms of strangulation.

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[1] Keen's Surgery, iv, 49; Rev. de Chir., 1902, iii, v, vi.

[2] Willard, Hernia, Med. News, xlv, 219; Trans. Phila. Path. Soc., v, 62, and vi, 19.

INGUINAL HERNIA IN GIRLS.

erience of the author and that of most American surgeons espond with French statistics in regard to the frequency of ia in young girls. In older females, even after the stretching inal walls and round ligament by pregnancy, Kirmisson[1] gives entage to inguinal hernia than to femoral. The difference in n of inguinal hernia between boys and girls is readily ex- n girls the peritoneal prolongation,—the canal of Nuck,— e only for the round ligament, while in boys the much larger sticle, must make its way to the scrotum through the inguinal).

osis the possible existence of hydrocele or cyst of the canal uld be recalled, as well as swollen glands, in addition to the natory diseases.

al infantile inguinal hernia in girls is usually curable by the plication of the wool bandage (p. 137) and later, for a year or hard-rubber light spring truss (Fig. 97). In persistent cases ulation, the sac should be exposed in the canal of Nuck, iso- e round ligament, opened and ligated high at its base with gut or kangaroo tendon so that when released it will return inal cavity. The aponeurosis is sutured and the skin closed ire intracuticular suture.

HERNIA, FEMORAL OR CRURAL. MEROCELE.

hernia (Fig. 104) may exist in either boys or girls, even as ears of age, but in the proportion of two females to one male. proportion of femoral hernia to inguinal is 1 to 16.

n.—If a truss fails to retain the rupture, an operation after the is advisable. While theoretically the internal femoral ring sed, it has been found practically that closure of the canal by g suture after high ligation and excision of the sac, is less d is not followed by relapse.

must be drawn well down, opened, emptied, ligated high up . A curved needle threaded with kangaroo tendon is then to Poupart's ligament at the roof of the canal and carried h pectineal fascia and muscle, then outward into the fascia ard through the roof of the canal near the point of entrance. ng of this purse-string suture effectually and permanently nal.[2]

CONGENITAL UMBILICAL HERNIA.

the hernia of a single loop of bowel at the umbilicus is so rare esent is so evident, it is strange that the old established gating the cord at a distance from the body is still continued.

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[1] Kirmisson, Précis de Chir. Inf., 151.
[2] Coley, Tr. Amer. Surg. Assoc., 1906; Keen's Surgery, iv, 76.

Dissection of the cord close to the umbilicus and ligation of the artery and veins would permit clean removal of the entire structure. Infection from a sloughing cord, sepsis, osteomyelitis, epiphysitis, and other serious conditions might thus be avoided.

If the peritoneal pouch exists at birth or fails to speedily close, the hernia is congenital; if it occurs afterward from colic, crying, or straining, the condition is denominated infantile acquired hernia. An umbilical rupture, especially in females, may take place at any time of life.

FIG. 104.—(Redrawn from Gray.) *A*, showing small pocket by side of femoral vessels, where hernia usually protrudes, breaking down Gimbernat's ligament and forming an elongated, triangular opening. The top of this triangle is Poupart's ligament; the floor, the tissues covering the ramus of the pubes; its base, the femoral vessels; and its point, the spine of the pubes. *B*, femoral artery. *C*, femoral vein. *D*, saphenous vein. (De Garmo, Abdominal Hernia.)

Congenital umbilical hernia occurs in about 1 in 5000 infants. The protrusion may be an embryonic malformation with large omphalocele, or may be a true fetal hernia. The former results from an arrest or improper development and non-union of the blastodermic layers;[1] the latter develops after the umbilicus is lined with peritoneum. The former variety is often accompanied by large escape of abdominal organs—exomphalocele, ectopion viscerum—(p. 155) or by a persistent omphalomesenteric duct.

[1] Stewart, Annals of Surgery, April, 1909, 566.

Treatment.—In infants, the tendency of an umbilical hernia is toward cure if intra-abdominal pressure is restrained. Theoretically, the narrowing of the opening and pressure upon its sides is accomplished by a wooden button mold or rubber plate and a broad band of zinc oxide plaster encircling the body (Fig. 105), but practically the adhesive plaster excoriates the delicate skin, interferes with cleanliness, and is of but little service. A light hard-rubber spring truss with pad and nipple (Fig. 106) large enough to press upon the borders of the ring but not to insert its apex into the opening, is decidedly preferable, and will usually in one or two years assist in closure. A pad with elastic band is also employed (Fig. 107). The truss must be frequently adjusted, must fit accurately, being changed as the child grows. It must be worn day and night, cleanliness being enforced as noted on page 138.

FIG. 105.—Kelly's method of combining plaster with hard-rubber plate. Plaster is folded back upon itself, and has buttonholes cut in it. (De Garmo, Abdominal Hernia.)

FIG. 106.—Infant's hard-rubber single-spring umbilical truss.

FIG. 107.—Soft-rubber belt with inflated air-pad.

For a small acquired umbilical hernia which resists truss treatment, the umbilicus and ring may be entirely excised, the fascia of the recti muscles split and the fascia and a few fibres of muscle drawn together and sutured with chromicized gut, or a minor overlapping operation may be done (p. 155).

INTESTINAL OBSTRUCTION.

The most common causes of intestinal obstruction in infants are malformations, intussusception, volvulus and intestinal bands.

In congenital malformation with ATRESIA of the small intestine, persistent vomiting will commence by the second day of life. Death from autointoxication will occur in a few days unless a celiotomy can disclose and relieve the obstruction.

A DIVERTICULUM,[1] either Meckel's or an offshoot from any portion of the bowel, may form an obstructive band. The lumen may be occluded soon after birth or many years later. The former structure is the remains of the omphalomesenteric duct which in fetal life forms a communication between the umbilical vesicle and the intestine. Such a diverticulum may be a blind pouch connecting with the intestine, or its lumen may remain open to the umbilicus giving rise to a mucopurulent discharge or even a fecal oozing (umbilical fistula, p. 157). The absence of urine will diagnose it from an open urachus. If the mucous membrane protrudes through the umbilicus, it will produce a tumor. Celiotomy is the only method of relief.

[1] Mayo, Trans. Amer. Surg. Assoc., 1907, p. 237.

CHRONIC INTESTINAL OBSTRUCTION may be caused by the slow invagination of a portion of the small or large intestine, or by inflammatory peritoneal bands, or by stricture following ulceration or by fecal impaction, or by congenital defects. The bowel above the constriction slowly dilates. The author recalls one of his patients who had permitted fecal accumulations to progress for years, the bowels being cleansed only once in three months.[1] After death caused by peritonitis from one of these efforts, both small and large intestines were found enormously dilated (p. 152).

Chronic obstruction from any cause may be accompanied by a watery diarrhea, deceiving both patient and surgeon.

Treatment.—Moderate obstructions may be temporarily relieved by slow cathartics, combined with small doses of belladonna, stramonium and opium, but the large majority of cases can only be benefited by CELIOTOMY and relief of the obstructing cause. Hardened feces in the rectum or sigmoid can be reached by oil or glycerine injections, or removed by finger or spoon.

INTUSSUSCEPTION.

The invagination of a portion of the intestine (INTUSSUSCEPTUM), with its elongated mesentery into a lower portion (the INTUSSUSCIPIENS) is essentially an accident of infancy, three-fourths of the cases being under two years of age.

Etiology.—Its occurrence at this age is due to the thin walls and greater mobility of the bowel and the irregular action of the muscular coats, often from the exaggerated peristalsis of diarrhea or from trauma. In infants it is the most common cause of intestinal obstruction. An unusual peristalsis having been started, the vermicular action of the intestine will continually carry the invaginated section downward through the bowel.

Pathology.—The result of this invagination, if unrelieved, will be inflammatory thickening of walls and adhesions between the middle and inner coats which will prevent reduction after the first few days. Peritonitis and sloughing follow. The invaginated portion usually begins at the ileocecal valve; having passed the valve it may continue through the colon and reach the rectum in less than twenty-four hours. The small intussusceptions of the jejunum found at autopsy are often only the results of irregular muscular contractions just preceding death. In chronic cases, the invagination may be slow and unrecognized.

Symptoms.—The symptoms are distinctive. In acute cases, the onset is sudden, intense and violent. The infant screams in agony at intervals of a few minutes; retching is followed by vomiting. The first stools may be frequent, but are speedily followed by blood and mucus without any fecal matter. These symptoms should always be looked upon with suspicion and an examination made of the abdomen and rectum Pallor, thready pulse, subnormal temperature, collapse and death speedily follow. At first if the abdomen is not rigid, a tumor can be detected; later with peritonitis, tympany develops and the tumor may be recognizable only through the rectum or under anesthesia. It is usually elongated, sausage shaped and may

[1] Willard, Phila. Med. Times, xiii, 533.

e colon. In chronic cases, the symptoms may be masked, but
ill be felt over the site of the invagination, or beyond it. The
removed with an ecraseur an apparently simple polypoid tumor
n, but discovered that he had taken away a section of the ileum
been invaginated by the traction of the tumor until it had
d at the anus. The opened intestine was anchored and the
vered.

is.—The cardinal symptoms are sudden, violent, intermit-
equent vomiting, one or two fecal stools quickly followed by
ucus, and the presence of a tumor along the course of the colon
tum or protruding from the anus. The existence of the tumor
to distinguish the disease from gastrocolitis, ileocolitis, dys-
other digestive disorders.[1] A rectal examination under ether
preparations for celiotomy is important. The case must not be
prolapsus ani or for hemorrhoids. Appendicitis while sudden
ot as violent, rigidity occurs early and tumor in the right iliac
on later from local peritonitis. Tenderness is more definitely
ppendicitis. Strangulated hernia should be sought for; if ex-
ernal, it will probably require operation. The presence of the
distinguishes the condition from volvulus and intestinal bands.

is.—In infants, practically all will die if not operated. If
the first day, 80 per cent. can be saved; if as late as the sixth
cent. will die. The fact that an occasional case has recovered
us sloughing is no excuse for deferring operation on account of
n hope. Clubbe, of Sydney, has reduced the mortality from 50
is first fifty cases operated upon in the third day, to 24 per cent.
l fifty, and 12.5 per cent. in his last series where the operation
seventeen hours as the average length of time between the on-
mptoms and the operation. These facts testify not only to his
rgical technic but largely to the influence that he has exerted
dical brethren, inducing them to submit their cases to him in
hours while there was hope and not delaying until all meas-
eless. As in appendicitis, the chances for recovery lie in early
terference.

at have been undiagnosed or treated medically for forty-eight
ldom be relieved even by surgical methods. A mass that has
s low as the rectum means that the case is far advanced,
peless.[2]

nt.—No cathartics are to be administered and opium should
until the diagnosis has been made and all preparations for
gun. The infant's arms, legs and thorax should be swathed
d he should be placed on an electric or otherwise heated mat-
r ether or chloroform, with patient on the operating table,
should be carefully examined and fifteen or twenty minutes
t (if condition permits) in trying the effect of inflation with air
ows or Davidson syringe, or of carbonic acid gas or hydrogen,

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mer. Surg. Assoc., 1906, 429.

Boston Medical and Surgical Journal, April 2, 1908, 435; Archives Pedi-
55.

or of injections of a pint of hot oil or salt solution from a fountain syringe placed twelve to fifteen inches above the buttocks. Inversion of the body may add the influence of gravity. Caution must be exercised not to rupture the bowel. In a few cases apparent reduction may occur with disappearance of the tumor, but there is no certainty that actual reduction has taken place.

If unsuccessful, the abdomen should be at once opened. The incision may be in the median line or at the semilunaris or over the tumor. If the tumor is not palpable, an empty coil of intestine may be followed. The

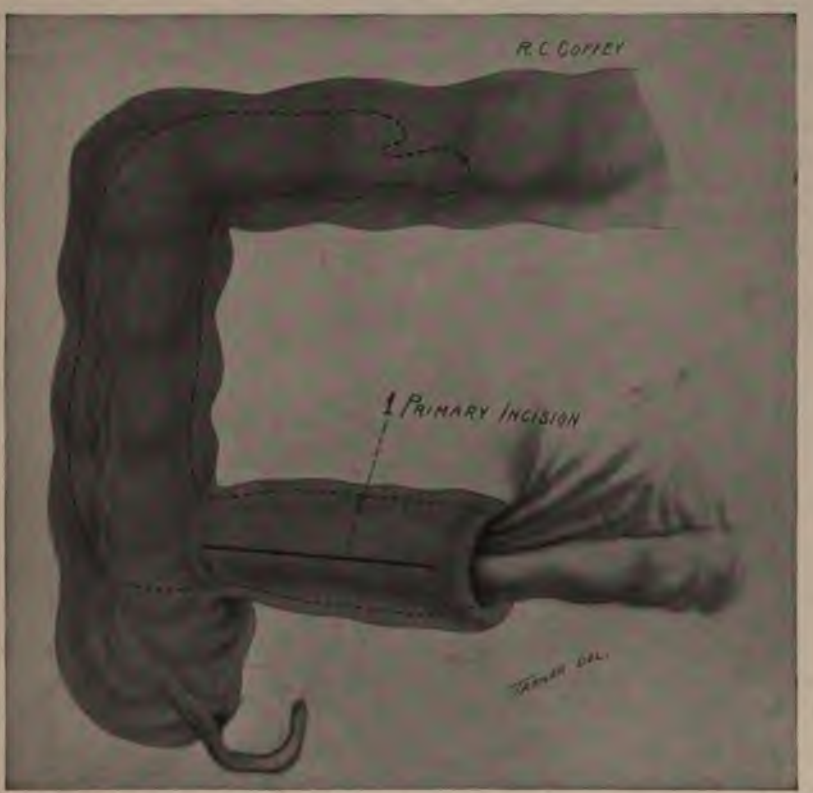

Fig. 108.—Invagination of ileum into the ascending and transverse colon. (Coffey.)

invagination is cautiously reduced by gentle squeezing, traction and manipulation. If adhesions prevent the freeing of the bowel, a resection of the intussuscepted portion will be necessary. Before resection, the invaginated portion should be still further pressed forward, in order that the excision be made in healthy tissue. After gentle clamping of the bowel above and below, a longitudinal slit in the intussuscipiens will permit rapid resection of the telescoped portion and circumferential suture of the stump. (Fig. 108). An end-to-end or lateral anastomosis with Connell suture or Murphy button or interlocking mattress suture, with closure of the slit and the speediest possible closure of abdomen, should save the child if the

s been done in the first twenty-four hours (Barker, Maunsell, :z).

nately, in young infants, resection is a very fatal operation, olongation of manipulation and lack of resistive power. In n, the operation is more hopeful. In gangrenous cases, with langerous symptoms, the bowel should be brought out of the l anchored to secure an artificial anus. In desperate cases ged operative interference will almost surely kill the patient, bring the bowel out of the wound and permit the slough to utside the body. The upper intestine is comparatively free enic germs. In obstruction in the lower ileum it is wise to incision into the bowel, introduce a tube or blunt ovariotomy vacuate the already infected contents.

the stomach before and after operation is advisable, as fecal ring etherization is liable to produce septic pneumonia or

REATMENT.—No cathartics or food or water should be given ld's cries become harmful. The infant may with advantage bath of hot milk and water.

VOLVULUS.

al obstruction from volvulus is not common in children. A of the large intestine, upon a congenitally long mesenteric lates the tissues, distends the bowel and favors speedy septic om bacterial invasion and gangrene.[1]

owel has been long distended, it may be so paralyzed as to be ntract even after being relieved of its contents.

ns.—The symptoms of total obstruction come on suddenly. ng, non-escape of feces and gas will be noted. Bloody stools ent than in intussusception. An abdominal tumor is usually no mass will be found in the rectum.

nt.—If large enemata in the knee-elbow position fail to re- iate celiotomy, untwisting of the bowel or resection of any portion, or the establishment of an artificial anus, is indicated.

REIGN BODIES IN INTESTINES OR STOMACH.

pins, coins, etc., are frequently swallowed by children. If ody,[2] especially one that is sharp or angular, passes into the *hartics should not be given* to hasten its passage through the If it is allowed to travel slowly downward it will become oated with feces and wounding of the mucous membrane pre- e diet should consist of potato in large quantities, oat- and eat, etc.[3] The most frequent points of arrest are at the anus ecal valve. If at the latter situation, an X-ray will disclose

[1] Keen, Keating's Cyclop. Dis. of Children, iii, 250.
[2] Poulet, Foreign Bodies, i, 140, 172.
[3] Keen, Keating's Cyclopædia Dis. Children, iii, 249.

the object if metallic, and if obstruction is permanent, a celiotomy will become necessary.

Enteroliths, gall-stones and fecal impactions become practically foreign bodies when they block the intestines. Sometimes they can be removed by small and repeated doses of castor oil, with oil enemata, together with gentle abdominal massage.

TYPHOID PERFORATION.

Perforation is rare in the typhoid fever of children, this accident happening in hardly 1 per cent. of cases. Its occurrence would be indicated by sudden pain, vomiting and collapse, with rapid development of tympanites. Immediate operation under local anesthesia with closure of the opening would of course be indicated as in adults.[1]

INFANTILE HYPERTROPHIC STENOSIS OF PYLORUS.

This condition is rare. It is admirably described by Stillman, who has collected 27 cases occurring in his own practice and in the Pacific States.[2]

The condition is sometimes a congenital hypertrophy and the stenosis of the pylorus may be discovered at or soon after birth. Spasmodic cases without hypertrophy may yield to medical treatment.

Congenital stenosis may be clinically different from *infantile* stenosis, yet diagnosis is difficult. The former requires very early operation. The prominent symptoms are regurgitation, vomiting, and progressive emaciation, with dilatation of the stomach and occasionally a pyloric tumor.[3]

Operation.—If persistent vomiting continues in spite of regulated feeding, gastric remedies and systematic lavage, operation is indicated. Hahn's or Loreta's stretching of the pylorus by invaginating the wall and dilating the orifice,—divulsion—is sometimes advisable. Posterior gastro-jejunostomy, or pyloroplasty, or pylorectomy may be done.

CONGENITAL IDIOPATHIC DILATATION OF COLON.

Synonyms: Hirschsprung's disease; giant colon; megacolon congenita; neuropathic dilatation of colon.

This condition is occasionally met with in childhood, even in infants. The bowels are obstinately constipated, the abdomen distended (Fig. 109), and intestinal pain constant. The author reported a case[4] in which power of retention of feces steadily increased. Four times in the year the cleansing of the bowels was accomplished by cathartics

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[1] Willard, Celiotomy for Perforation, Annals Surg., xxix, 1899, 503; Tr. Phila. Acad. Surg., i, 140.

[2] Trans. Surg. Sec. Amer. Med. Assoc., 1909; Jour. Amer. Med. Assoc., Nov., 1909, 1546.

[3] Archives Pediatrics, Nov., 1908, 806, 875; Bunts, Trans. Amer. Surg. Assoc., 1908, 226; Surg., Gyn., and Obstet., 1906, iii, 521.

[4] Willard, Phil. Med. Times, xiii, 533–539.

and injections; after one of these cleansings, which lasted for days, death resulted. The colon was enormously dilated (p. 147).

Diagnosis.—The outline of the colon can be defined by the X-ray after the injection of bismuth, but the amount of bismuth required to fill the colon is dangerous.

FIG. 109.—Congenital dilatation of colon.

The cause of this disease is probably an anomaly of development or a long mesentery. The dilatation and hypertrophy may be due to an aplasia of muscular tunics, or to a hyperplasia of the lymphatic and vascular elements.

The prognosis is unfavorable from the dangers of peritonitis. A mortality of 50 to 60 per cent. is reported in cases medically treated. Surgery offers a lower mortality and much higher proportion of final recoveries.

Treatment. — Cathartics, high enemata, massage, and electricity, give temporary relief. EXPLORATORY CELIOTOMY, with colostomy at some indicated point above the healthy bowel, offers the best results. Through this artificial anus the colon can be irrigated. Later, if only a local section of the colon is dilated, this area may be resected and a lateral entero-anastomosis above and below performed.[1]

GENERAL PERITONITIS.

Peritonitis in the new-born is often INFECTIOUS from the umbilicus, or is due to malformations. Streptococcic or pneumococcic peritonitis is more common in children than in adults. Infections from the Bacillus coli communis are more favorable than those from streptococcus. Abdominal pains and vomiting may exist without any infection from the appendix. In certain cases the absence of abdominal rigidity and of tympanites makes diagnosis difficult, especially if there is diarrhea.[2] In adolescent girls, the condition may arise from gonorrheal vulvovaginitis; in boys, often from injuries.

Vomiting, pain, tenderness, distention, rising pulse and temperature, will indicate the approaching trouble. The vomiting soon becomes the gulped greenish fluid of peritonitis, the countenance is anxious, and collapse and death often speedily follow. Any of the various pathogenic germs may be present. In some acute cases, the diagnosis of the cause will be obscure, and the source of the infection is sometimes undiscoverable even after celiotomy.[3]

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[1] Finney, Trans. Amer. Surg. Assoc., 1908, 475; Complete bibliography.
[2] Dowd, Annals of Surg., 1908, xlviii, 826.
[3] Martin, Ann. of Surg., Dec., 1906, xliv, 917.

Treatment.—Absolute rest with dry calomel on the tongue will lessen vomiting. In older cases lavage of the stomach is helpful and ice-bags will give relief from pain. The treatment of peritonitis, however, consists practically in opening the abdomen and the discovery of the causal lesion. Peritonitis without a local cause is exceedingly rare, consequently diligent search should be made for a perforative appendicitis, trauma, enteritis, intussusception, intestinal obstruction, typhoid perforation, or other potential agent. The operative precedures are described under appendicitis (p. 126); intussusception (p. 149), etc.

TUBERCULOUS PERITONITIS.

Tuberculous peritonitis is usually a chronic condition but is subject to exacerbations. Multiple minute tuberculous nodes may stud the peritoneal surface similar to the foci found in acute miliary tuberculosis. Later in the disease, plastic fibrinous exudates form adhesions between the loops of the intestines or fasten them to the abdominal walls. Confluent tubercles form cheesy masses around which gray miliary tubercles are found. Serous effusion is usually present and may largely distend the abdomen (Fig. 110).

FIG. 110.—Caseous peritonitis with moderate exudate. Great emaciation. Boy three years of age. (Pfaundler and Schlossmann.)

Suppuration is rare. Reddening of the skin above the umbilicus may exist in pus cases but is also found in large ascites. Disease of the kidneys, heart, or liver, or abdominal tumors may give ascites but rarely the progressive emaciation and malnutrition of tuberculous peritonitis. Tuberculosis of the ovaries or tubes may be the point of origin even in infant girls.

Cases of chronic peritonitis in children arise from the infection of the tubercle bacillus, the invasion proceeding from a primarily involved

n the intestinal tract. The mesenteric lymph-nodes may or secondarily involved.

RATIVE form with cheesy degeneration is found in children. ow nodules and the larger caseous masses break down in the duce either pus or a brownish liquid. In infants the deposit iliary, but as the discrete and conglomerate masses increase, es more and more prominent and the abdomen becomes ded. The abdominal fluid is greenish or seropurulent or ciation is not rapid, but weakness and prostration are pro- the plastic or fibrous form, adhesions between the coils of and peritoneal surfaces are firm.

s.—Progressive emaciation and malassimilation, diarrhea and tention with gas or peritonitic fluid are usually present. Pain t. Palpation will sometimes disclose omental or mesenteric an intestinal agglutination tumor if the examination is made urrence of ascites.

.—Under proper medical and surgical treatment, the moist es are frequently benefited; the dry, plastic agglutinative re unfavorable, but the disease will be greatly delayed by is measures; the ulcerative ones are always fatal.

t.—An abundance of sunlight with prolonged open-air treat- d night, at seashore or mountain, as outlined on p. 380, are ortant elements in arrest of the infection. Rest and gener- important.

s of the abdomen or of the entire body, twice daily, with e oil 0.5 per cent., or with codliver oil, are most beneficial. les, iron, arsenic, and tonic doses of corrosive sublimate ($\frac{1}{300}$) helpful.

E TREATMENT.—Celiotomy with small incision, large flush- ominal cavity with hot saline solution (110° F.), and prompt wound have been so successful as to leave no doubt as to the this method of treatment as a routine. The injection and live oil, sterilized for one hour, will prevent adhesions. At ation, this oil should be medicated with a quarter of one per .

rable amount of salt solution may remain in the cavity. Its ct will be increased by adding 1: 1000 Lugol's solution of e the tying of the last stitch, the abdominal cavity may be h oxygen gas, which is retained by prompt closure of the

nation of the cure is probably due to the fact that the with- l removes the tuberculous toxins which have remained stored eal cavity after Nature has to a large degree contested the relief of tension has permitted the entrance of fresh bacterial e cavity. When Fallopian tubes or the appendix are the seat ulous disease in adolescents, cure has often been permanent of the original focus, with possibly a second operation. A n of fluid after primary tapping should be followed by a search for the causal focus.

EXOMPHALOCELE; OMPHALOCELE.

The author has recently seen, in consultation with Dr. O'Hara, a new-born infant, from whose umbilical region protruded almost the entire intestinal tract (Fig. 111). The tumor covered nearly two-thirds of the abdomen, and through the thin, transparent bluish white walls the constant vermicular action of the intestines was plainly visible. By careful taxis the intestines could be reduced and an opening in the abdominal walls discovered sufficiently large to admit two fingers, but the tumor instantly refilled when the fingers were removed. Healthy skin surrounded the tumor. The child was otherwise normal. The umbilical cord coursed along the side of the mass and was adherent to it. Several discharges of meconium had occurred and the infant had only vomited mucus.

FIG. 111.—Omphalocele in new-born infant. Movements of intestines were plainly visible through the thin transparent wall.

Operation at the end of forty-eight hours. The sac was already showing signs of necrosis, and, on making the transverse flaps, darkly stained bloody fluid from infection of the peritoneum oozed freely. The tumor contained no abdominal organs except the intestines. With much difficulty the latter were reduced and the opening tightly closed with overlapping mattress sutures (Mayo), the lower flap being well drawn up beneath the upper one, and a firm imbrication secured, tightly closing the opening.

The child lived thirty-six hours after operation, dying evidently from the autoinfection and peritonitis. Operation on the first day is advisable.

In large congenital openings permitting prolapse of abdominal organs (p. 145),—OMPHALOCELE,—the overlapping flap operation of Mayo[1] as practised in adults, should be employed. Two transverse elliptical incisions are made, saving all good skin, the pouch is opened, adhesions loosened and the tissues separated around the neck of the sac. The aponeurotic structures are dissected upward and downward to form two flaps (Fig. 112) and the peritoneum is separated from the under surface of each flap. Two-thirds of an inch above the margin of the upper flap a silver wire or chromicized gut or celluloidal linen suture is then inserted, carried down through the lower flap near the margin, then reversed as a mattress suture, and carried back to meet its fellow in the upper flap. Other sutures are inserted in the same manner but are not tightened until the peritoneal flaps beneath are closed by continuous catgut sutures.

[1] Mayo, W. J., Tr. Amer. Surg. Assoc., xix, 1901; Keen's Surgery, iv, 89.

The tying of the mattress sutures then draws the lower flap far up between the peritoneum and the aponeurosis of the overlapping flap. Finally, the margin of the upper flap is sutured to the surface of the lower flap, the overlapping imbrication giving a double-wall support. The skin is closed separately and a firm pad applied.

FIG. 112.—Overlapping mattress sutures drawing the under flap beneath the upper one. (Mayo.)

OPEN OR PATENT URACHUS—URACHAL TUBULOCYST.

In early fetal life the pouch from the lower end of the primitive intestinal cloaca, the allantois, projects upward and forward through the umbilicus, but at about the seventh month the upper portion should normally become obliterated into a fibrous cord, while the lower portion forms the urinary bladder. The fibrous cord extending from the top of the bladder to the umbilicus is then known as the URACHUS. If it remains patulous after birth, urine may slowly ooze from the umbilicus when the bladder is full or if any interference to micturition exists. A persistent oozing from the umbilicus should always lead to investigation with a probe.

Treatment.—The primary indication is to remove all obstructions to free discharge of urine from the urethra, as contracted prepuce, adherent labia, or calculus, and to encourage the frequent emptying of the bladder.[1] If the urachal track is small it may be closed by the application of a slender electric cautery, but this method is more dangerous than excision or a plastic operation. The author closed one case permanently by laying open the dilated urachus at the umbilicus and curetting its walls. After cauterizing the whole interior with zinc chloride, a drain was introduced and withdrawn slowly, day by day.[2] Previous cauterization of the edges of the opening and plastic paring and suturing had failed. After an operation the child for ten days should urinate frequently.

UMBILICAL FISTULA.

A fecal fistula at the umbilicus may be due to a strangulated umbilical hernia, or an open Meckel's diverticulum, the omphalomesenteric duct which in embryonal life leads from the lower end of the ileum to the umbilical vesicle. Ordinarily it closes before birth but when persistent as a fibrous cord, or as a diverticulum from the intestine, may cause internal strangulation or a diverticulitis. A celiotomy with closure of the tube is the only method of cure.

Umbilical Polyps and Granulomata.—These umbilical tumors are very vascular. They should be ligated and dressed aseptically with boric or zinc stearate powder.

Umbilical Sepsis.—Thrombosis of the umbilical vein from a sloughing cord in a new-born infant may infect the liver, producing jaundice, or give rise to general septic invasion, with epiphysitis (p. 599), osteomyelitis, abscesses, etc. Neither the burnt linen of former days nor the boracic acid dressing of the present is able in certain cases to prevent this unfortunate accident. The infection would be less frequent if the cord were dissected to prove the absence of intestine or diverticulum, the blood-vessels ligated by themselves, and the remainder of the cord excised (p. 145).

UMBILICAL HEMORRHAGE.

Hemorrhage from the navel may appear immediately after birth from too violent traction on the cord during delivery. It may also occur from inefficient tying of the cord. Later, it takes place with jaundice, from obliteration of the bile ducts, from a hemorrhagic diathesis, or from ulceration around the base.

Treatment.—Pinching the umbilicus with the fingers is the speediest method of arrest. A ligature, or alum, adrenalin or other styptic, ice, ethyl chloride spray, or the thermocautery, may become necessary. In dangerous hemophilic cases, with parts rendered antiseptic, two harelip pins may be introduced and a figure-of-8 suture applied for three or four days. Even the puncture of the needle may ooze, but the ligature will

[1] Vaughn, Trans. Amer. Surg. Assoc., vol. xxiii, 273.
[2] Willard, Open Urachus, Medical News, liii, 710; Trans. Phila. Acad. Surg., 1888.

usually control the bleeding. Thyroid extract, adrenalin, or calcium chloride may be administered. OIL OF ERIGERON CANADENSIS internally, one drop on sugar every hour, is a valuable remedy.

IMPERFORATE ANUS AND RECTUM.

The origin in fetal life of the genito-urinary organs and of the lower end of the intestines from a common cloaca, easily accounts for the many deviations from the normal that result from misdirected formation, or from faulty union of embryonal tissue. This malformation occurs in about 1 in 10,000 births. In the fourth week of fetal life the posterior segment of the primitive tube is shut off by a partition, the cloacal membrane, formed by the union of the ento- and ectoblast. The anterior compartment becomes the urogenital sinus; the posterior, the rectum. By the sixth week, the folds forming the anus and the external genitals appear. The fold of Rathke separates later the genital and rectal pouches, the partition becoming the perineum. If the involution of the epiblast fails to produce the anus, or to reach the pouch from the internal blastodermic layer, an imperforate anus or rectum results. The rectal pouch may reach almost to the anus or end far above it, or the lower rectum be present and a bridge of tissue occlude it from the sigmoid (Fig. 113).

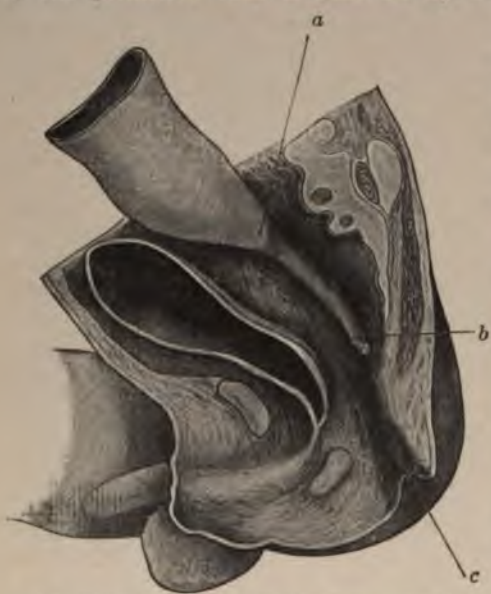

FIG. 113.—Simple artresia of the rectum. *a*.—Blind end of the rectum. *b*.—Strand of firm tissue extending from the blind end of the rectum to the anus. *c*.—Tract opened by operation. (Pfaundler and Schlossmann.)

In other cases where the confusion of development between the rectal pouch and the allantois structures, bladder, and Wolffian ducts, is marked, the rectum may open into the urethra, vagina, bladder, or penis. The PROCTODEUM is that portion of the anal invagination of the epiblast which is distinct from the primitive hypoblastic part of the bowel, but subsequently becomes united with it to form the lower portion of the intestine.

A small catheter or probe in bladder or vagina may assist in diagnosing congenital CLOACAL OPENINGS.

The anus may be closed congenitally simply by a membrane, or the normal site may be represented only by a dimple of the ectodermal layer. In other cases, especially in absence of the rectum, the perineum may be perfectly smooth. When there is no bulging of the perineum during straining and no escape of meconium from the bladder or through a sinus, it may be inferred that the terminus of the enteron is located high up in the rectal ampulla.

Symptoms.—Disinclination of the infant to suck, restlessness, straining, distention of the abdomen, occasional vomiting, jaundice, venous stasis, and failing vital powers are sufficiently indicative of the dangerous process to cause a complete examination of the perineum. The distention of the abdomen usually masks the location of any obstruction and the intestine may terminate at any point or be complicated with other malformations. A little chloroform may be needed during operation, but every precaution must be taken against shock.

Operative Treatment.—(1) Perineal incision, simple; (2) perineal incision with drawing down of gut; (3) colostomy to form a temporary artificial anus; (4) combined abdominal and perineal incisions with proctoplasty; (5) excision of coccyx or sacrum.

(1) Perineal Incision.—An imperforate anus if closed only by a bulging membrane may be opened by a simple incision without anesthesia, the mucous membrane sutured to the skin, and the part dilated with the finger daily.

(2) Perineal Incision with Search for the Bowel.—The obstruction to the escape of the meconium must be relieved within the first forty-eight hours or the child will die from autointoxication. If no anus exists, an incision should be made at the normal site of the opening and the rectal pouch sought by dissection, guided by a catheter in urethra or vagina. When the finger and the eye detect the dark color and the bulging mass of meconium, an exploring needle or a small trocar may be used for diagnosis. If the intestine is found after careful dissection of about two inches, the contents are evacuated, the end loosened and drawn downward as low as possible and sutured. The stercoremia of the infant is usually so profound that prolonged operation is dangerous. Shock and hemorrhage are illy borne. If the deficiency is great the posterior wall may be followed along the coccyx and sacrum and the opening made as low as possible; if the peritoneal cavity is opened, it should be stitched. The great danger is in the subsequent formation of stricture. After washing with bichloride, a rubber tube surrounded by gauze and well anointed with carbolized petrolatum, is left protruding from the anus. If sphincter fibres are discovered, they should be sutured.

(3) Colostomy.—If the pouch is not reached before the peritoneum is encountered, it is much wiser to give immediate relief by a left inguinal colostomy[1] (Littre) or by an opening in the left loin[2] (Amussat), or if the sigmoid is absent, the opening may be made in the cecum. If the resulting artificial anus does not permit prolapse of the bowel, there need be no haste in seeking for the rectum and performing a proctoplasty.

(4) Combined Abdominal and Perineal Proctoplasty.—The perineum may later be opened, a flexible bougie passed down through the bowel from the artificial anus to locate the pouch, the intestine sought, loosened, brought down, and sutured as low as possible. A small catheter in the urethra of a boy and in the vagina of a girl will assist in identifying the tissues.

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[1] Kirmisson, Précis de Chir. Inf., 192.

[2] Wharton, Keating's Cyclopædia Diseases of Children, iii, 328.

method is to perform a celiotomy, the lower end of the bowel
t down and fixed in the best possible location by perineal
In successful cases of proctoplasty, dilatation with rectal
be necessary for years.[1]
ctum ends in the vagina and control of feces is secured, no
d be attempted unless it is demonstrated in later years that
uch is near the anus, in which case perineal proctoplasty and
on would be advisable (Rizzoli) with closure of the posterior

ISION OF COCCYX is not advisable in children.

s.—Success will depend largely upon the site of the lower
the enteron and the prompt discovery of the malformation.
fect is simply an imperforate anus, or when the pouch is near
, a good result may be expected if the condition is discovered
autointoxication has taken place. In delayed cases, where
ion of the bowel is too high to be reached through the peri-
ortality will be large, whether operated or not.[2] Ashhurst
graphy[3] gives the mortality in perineal proctoplasty as 22
d in abdominal operations as 65 per cent.
ives 50 deaths in 100 cases and Anders 36 in the same number
The majority of fatal cases die from autoinfection and from

PROLAPSE OF THE RECTUM.

is ani, prolapsus recti, and procidentia recti represent three
trusion of the rectal wall. In simple cases there may be only
of the mucous membrane just above the anus; in others the
muscular walls are prolapsed, and in extreme cases, the peri-
be dragged down, or a true intussusception occur. In weak
h relaxed sphincter ani and levator ani and lax connective
ping-cough, constipation, diarrhea and long sitting at stool
causes. Prolapse may occur in infants and is most frequent
years of age.

is.—A visual and manual examination will readily distin-
ndition from hemorrhoids, polypus and intussusception.

nt.—With proper treatment, an operation is seldom neces-
nts or children. The removal of the exciting cause is of first
Constipation and diarrhea must be corrected, diet regulated,
ed, worms destroyed, a contracted prepuce stripped or cir-
a vesical calculus removed. The child should not sit and
at stool, especially over hot water, but should be laid upon
ring defecation and vigorous efforts restrained, the buttocks
ctal tissues being supported by the nurse. In severe cases,
injections are better than gluten or glycerine suppositories.
ion, expulsive efforts can be stimulated by gentle manipula-

Archives Pediatrics, Sept., 1907.
Surg., Gyn., and Obstet., Sept., 1908; Matas, Trans. Amer. Surg. Assoc., 1897.
t, Med. Bulletin Univ. Penna., July, 1907, 96.

tion of the anus. After defecation, a prolapsed bowel should be at once returned by inverting the child, anointing the mass thoroughly with tannic acid ointment and reducing first the central portion of the mass with the finger, followed by gentle taxis of the entire protrusion. A small suppository of tannin, alum, ergot, or other astringent is then introduced and the child kept upon its face or side for a half hour with the buttocks held together with a wide strip of adhesive plaster. In larger children, a pad or T-bandage is helpful.

By these measures and by development of the general muscular tone and possibly by electric treatment of the sphincter ani and by small doses of strychnine, a cure can be obtained in a large majority of cases.

Operative Treatment. — LINEAR CAUTERIZATION. — In stubborn cases, three or four longitudinal sections of the rectal mucous membrane may, under anesthesia, be successfully seized with rectal clamp and removed by the thermocautery. This method is more exact than linear cauterization with nitric acid or silver nitrate. After any operation, the buttocks must be strapped, the child confined to bed upon its face or side for several weeks and general treatment continued.

PROCTORRHAPHY.—Lange's method of removing the coccyx and suturing the tube is never required in children (rectococcypexy) nor is Roberts' posterior elliptical resection and suture necessary.

PROCTOPEXY OR RECTOPEXY — COLOPEXY. — Stitching of the prolapsed rectum through a posterior opening, as advised by Tuttle, Verneuil and Peters, is rarely if ever necessary in children. Stitching the rectum through an incision in the groin or by celiotomy is only needed in adults. Amputation of the rectum would only become necessary in case of strangulation and gangrene.

CIRCUMFERENTIAL NARROWING. — Another operation that secures temporary narrowing of the calibre is performed by partially surrounding the rectum with a thirty-day chromicized gut ligature. This is introduced on a curved needle above the anus, is made to traverse three-quarters of the circumference, is then reversed and brought back to its site of entrance and loosely tied so as to pucker but not occlude the rectum.

RECTAL POLYPI.

Tumors consisting of fibromatous tissue and attached by a pedicle to the mucous membrane are not infrequent in children. They may be protruded from the anus during defecation and drag down the wall of the rectum with them. The author many years ago removed such a polypus from the rectum with an ecrazeur, and was astonished to find that he had removed with it an entire section of the ileum which had been invaginated with the tumor from above the ileocecal valve. The divided intestine was anchored and the patient recovered.[1] Since that experience he has always endeavored to deliver the tumor from the anus before ligating it.

[1] Willard, Trans. Phila. Path. Soc., viii, 26.

HEMORRHOIDS OR PILES.

oids are less common in children than in adults. These tumors
s of the venous structures produced largely by the thin walls,
ive tissues, and the absence of valves in the lower hemor-

AL HEMORRHOIDS are tumors external to the sphincter and
with the thin skin of the anal folds. INTERNAL OR BLEEDING
ated higher up and are covered with mucous membrane only.
may be both external and internal.

—Added to the above anatomical conditions, the straining
ipation, diarrhea, tenesmus, vesical calculus, worms, heavy
nay in adolescents produce a rupture of a vein in an external
tation of the venules of an internal hemorrhoid. The tumor
will be extruded from the anus and by ulceration of the
brane will bleed profusely, thus in time seriously endangering
nodest girls and careless youths the retention of the tumors
nus may end in sloughing. Cases of long standing may be
by prolapse of the bowel with pruritus.

s.—The diagnosis from polypus, prolapse, fissure, etc., can
ade by visual, manual and instrumental examination.

nt.—Hemorrhoids are best treated by scrupulous attention
after defecation and by the relief of constipation, diarrhea,
acted prepuce, vesical calculus, and any other causal agents.
water from a bidêt against the anus or a wash of hamamelis
s healing. An ointment of tannic acid, cocaine, camphor,
phia, and lanolin should be applied to any tumors protruded
ation and the masses entirely returned to the rectum, pro-
re not external piles. If an EXTERNAL HEMORRHOID becomes
the subject of thrombophlebitis, a lump of ice wrapped in
hamamelis and placed against the anus will give comfort, pro-
added. A four per cent. solution of carbolic acid applied with
tly to the tumor will lessen pain.

st efficient treatment for an inflamed external hemorrhoid,
o slit it in half with a very sharp bistoury, under cocaine or
e spray, to turn out the clot from the ruptured vein, and apply
acid to the interior with a small swab, neutralizing it with
applying a wet hot aseptic dressing.

skin about the anus from obliterated external hemorrhoids
inized and cut away with scissors.

L OR BLEEDING HEMORRHOIDS.—*Palliative Treatment.*—The
eatment is similar to that already mentioned. Whenever
m the anus the tumors should be thoroughly anointed and
up the rectum and an anodyne astringent suppository in-
positories of belladonna, tannic or gallic acid, cocaine, mor-
enthol are helpful. Aristol, ergot, opium, stramonium also
ng, or an injection of potassium bromide. Ulcerated sur-
e touched with a 20-grain solution of silver nitrate or copper

Radical Cure.—Operative relief is indicated in all persistent and severe cases: (1) electrocautery; (2) clamp and cautery; (3) ligation; (4) excision; (5) injection.

(1) Electrocautery.—In boys or girls obliged to earn their living, small hemorrhoidal tumors may be cocainized and through a rectal speculum may be destroyed one at a time with a small electric cautery point.

(2) Clamp and Cautery.—The best operation is the clamp and cautery, under anesthesia. This method possesses the advantage of full and immediate removal of the tumor, of leaving no sloughing masses to infect the rectum as does the ligature; pain is less and cure is speedy. After thorough cleansing of the bowel and after full dilatation of the sphincter, each tumor is drawn down separately. If external hemorrhoids coexist, the skin should be incised with scissors, leaving the outer portion of the loose skin folds about the anus so that there may be no subsequent contraction. This lessens the mass and causes the upper portion of the tumor to be clamped as tightly as at the lower portion. Clamp forceps, however, should be made to close a trifle more closely at their tips than at the

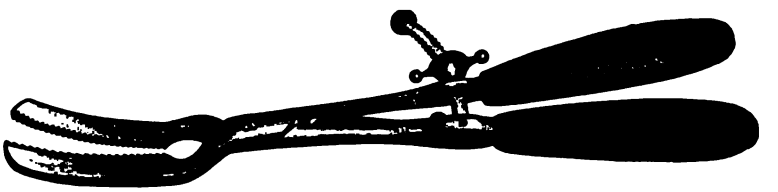

FIG. 114.—Hemorrhoid clamp; blades close improperly.

base, since the upper area is the most troublesome in case of bleeding. The masses are seized with ring forceps in the line of the axis of the rectum. The clamp (Fig. 114) is tightly applied, turned out from the anus, and the entire tumor slowly reduced with a dull-red thermocautery appliance or soldering iron. The skin should be protected with asbestos pad or wet gauze. An anodyne suppository and a pad of aseptic gauze anointed with petrolatum is most comforting. Hemorrhage in clamp operations is due to improper clamping, or insufficient or too rapid cauterization, or rudeness in removing clamp or in subsequent manipulations. If it occurs after the operation, it is best controlled by alum packing or by forceps left in position for twenty-four hours. Gas in the bowel should be withdrawn by catheter or syringe tip. If the child is unaccustomed to the use of the bedpan, it is better to place him upon a commode than to use a catheter to draw urine. Mild doses of calomel should be commenced on the following day and a small dose of compound powder of licorice or castor oil given each night to secure one soft mushy stool daily. An enema of linseed oil is helpful.[1] Hardened stools should never be allowed to accumulate in the rectum.

A gauze sponge, with silk cord, inserted high in the rectum will prevent oozing of feces during the operation. The only instrument or article that the author has ever been guilty of leaving in a wound was a sea

[1] Adler, New York Med. Rec., lxxii, 392.

t anchor line, left in the rectum and which resulted only in a
r looking stool"; once, also, a gauze sponge.
tion.—Each tumor may be drawn down and tightly ligated
e ligation of hemorrhoids, however, leaves sloughing masses
which are productive of pain and distress, irritating to the
ngerous as regards infection. A path in the skin for the liga-
e made with scissors to avoid pain and hasten the slough.
icture may necessitate the prolonged use of bougies.
ision.—Excision of each pile with immediate closure of its
tinuous catgut suture exposes to infection and perirectal
tehead's extensive excision, with stitching of mucous mem-
kin, is rarely required in children.
ction.—The injection of hemorrhoids except in experi-
as resulted in many sloughing abscesses and death. It is not
hildren except in self-supporting adolescents. Full etheriza-
lamp and cautery are preferable for younger cases. The ad-
e injection method in experienced and careful hands are that
ntion to business, avoids the necessity of prolonged anesthe-
rming, and is more readily accepted. Its disadvantages are
l time of treatment, the dangers of sloughing and thrombo-
rbolic acid forms the base of most of the injections employed.
ypodermically two-drop doses of a mixture of carbolic acid,
c acid dr. ½; boric acid dr. 1; sterilized glycerine oz. 1. Martin[2]
o ten drops of a 50 per cent. sol. of the original French prepa-
nol sodique (Phenol Boboeuf). This should be freshly pre-
, and with an equal part of distilled water should be clear and
l sphincter is forcibly divulsed under nitrous oxide anesthesia.
ter, through a rectal speculum, one hemorrhoid is exposed,
n antiseptic like creolin, touched with cocaine solution, and
nims of the prepared solution are injected by hypodermic into
the tumor. A suppository is introduced and in a few hours
sumes his duties, the divulsion having avoided pain and stran-
e other tumors are similarly treated every two to five days,
me, several weeks being consumed in multiple hemorrhoids.
ng from hemorrhoidal irritation may be greatly relieved by:
℥ss; pulv. calamin prep. ℥i; zinci oxidi ℥ij; glycerine ℥iii;
aq. rosæ qs. ft. ℥iv.

PRURITUS ANI.

s caused by such a variety of conditions that most careful in-
necessary. Hemorrhoids, fissure, eczema, worms, constipa-
nd tumors, benign and malignant, must be removed. Car-
ns, 1 to 2 per cent. in glycerine or in water, are often helpful,
f bismuth subgallate, zinc oxide, or zinc stearate carbolated
are indicated. Hot water ablutions, sodium hyposulphite

[1] Tuttle, Diseases of Rectum and Anus, 1903.
[2] Amer. Med., Aug. 27, 1904, 365, and Nov. 25, 1905.

solutions, camphor and chloral equal parts, dilute camphophenique, menthol, ointment of zinc oxide, and in severe cases a 5 per cent. silver nitrate solution may also be employed. Adler recommends ext. hamamelis fld. ℥i; ext. ergot fld. ℥ii; ext. hydrastis fld. ℥i; tinct. benzoin co. ℥ii; ol. oliv. carbolized ℥i; sol. acid carbol. (5 per cent.) ℥i.

FISSURE OF THE ANUS.

A fissure or lineal ulcer at the verge of the anus sometimes occurs in infants, and gives rise to severe pains at stool, with tenesmus and sometimes prolapse. In older children the pain of fissure differs from hemorrhoids (with which, however, it may be associated) by its intense character at the moment of the passage of hardened feces, then subsiding temporarily but reappearing with increased intensity a half hour later and becoming burning and spasmodic in character. The amount of hemorrhage varies in both conditions. In adolescent girls the continuance of this condition produces a most distressing array of nervous symptoms, amounting to hysteria or even insanity, which may pass away by the simple cure of the fissure.

Diagnosis.—The diagnosis is made by a careful separation of the margins of the anus, taking care not to tear the delicate skin and mucous membrane. Either anteriorly or posteriorly a delicate red ulcerated line with indurated borders will be discovered, bleeding easily and extending sometimes well into the rectum. On account of the pain and bleeding, the condition will often be mistaken for piles.

Treatment.—Ointments and suppositories of belladonna, lead acetate, cocaine, tannic acid, etc., are only soothing. Temporary relief may be secured by touching the linear ulcer with pure carbolic acid, or silver nitrate solution, or by acetanilid or menthol, but permanent cure is seldom obtained except by operation. DILATATION and LINEAR CAUTERIZATION, under ether, usually cures in infants. In older children the sphincter may be thoroughly stretched and the ulcer incised, or if indurated thoroughly resected, the edges then being sutured with chromicized gut. In extreme cases, the external sphincter may be divided.

FISTULA IN ANO.

An abscess in the ischiorectal fossa, if incision is delayed, may discharge into the rectum or externally, thus making a complete or an incomplete fistulous track.

Diagnosis.—If the internal opening cannot be readily discovered by a finger in the rectum and by a probe in the sinus, further manipulation should be deferred until the patient is anesthetized for operation. It should always be remembered that a fistula in children may be the result of spinal caries, hip tuberculosis, or sacro-iliac disease.

Treatment.—Fistula is best avoided by early opening of an ischiorectal abscess. The pain from pressure upon the nerve filaments fortunately leads patients to seek early relief.

INJECTIONS OF BISMUTH.—In straggling and branched sinuses, injection of bismuth 1 part and vaseline 2 parts will, under the X-ray (p. 400), disclose

ons and permit operation with less injury to the sphincter.
rnal rectal opening is present the injection may effect a cure.
.—If the opening is not too high in the rectum, or if multiple
t present, incision is the speediest and surest method of cure.
esia the sphincter is dilated, a flexible grooved director carried
is until the internal opening is discovered by the finger in the
o internal opening can be found, the director is carried to a
d forced through the membrane against the finger. The tip
ht out of the sinus and the track slit with a bistoury, and

ie element of cure is to compel the sinuses to heal by granu-
e bottom, consequently in newsboys or others obliged to earn
small sinus can be laid open under local anesthesia. A rub-
is then furnished him and he can be instructed to wash the
ss the shielded finger wet in bichloride solution through the
defecation, thus preventing skin adhesion. This method is
o that of packing.

AND SUTURE.—If the track is short and the tissues fairly
walls of the sinus may be excised and the edges sutured.
of chromicized gut sutures should bring together the walls to
om of the sinus; the second row should include only the skin.
ould be closely watched and if primary union fails, the lips
arated and the track packed as in the usual operation. No
healing will have occurred by the attempt at closure. If ex-
feasible the diseased sinus wall may be destroyed by knife,
utery, and the wound packed with aristolated gauze after the
norrhage. Subsequent packing will compel healing of the
e bottom, the granulations being stimulated by iodine as

tment of a fistula in phthisical adolescents, where the constant
the perineum in coughing is serious, will depend upon various
s. If the presence of the sinuses and the amount of discharge
the patient, closure can be secured by operation if the repara-
re still good, but success must not be too positively assured,
tic ligature is usually preferable. Horseshoe and branched
ten be slit into each other and thoroughly opened with but one
gh the sphincter, since only a single opening may exist in the
ontinence of feces and of flatus will thus be avoided.

LIGATURE.—In single fistula, when incision is refused or when
ends high up in the rectum, or in tuberculous cases, or when a
g boy or girl desires to avoid interference with business, an
e may be employed.

eyed bent probe, a silk ligature is carried through the sinus
um and out of the anus. To this is attached a rubber cord
one-twelfth of an inch in diameter, which is drawn through the
of the skin opening. The skin included in the loop should be
r cocaine or ethyl chloride spray to save pain and expedite the
ocess. The rubber cord is then tied tightly, the first knot
held by tying it over a crossed silk thread, which latter,

when knotted, prevents slipping. Such a ligature will cut through in a week or two with but little pain, after which packing and cleansing will compel the wound to close by granulation.

CAUTERIZATION.—The galvanocautery or thermocautery is seldom used in children.

WOUNDS OF THE RECTUM.

Wounds of the rectum may be produced by falls upon sharp or pointed objects, or by rupture from a carelessly introduced syringe point, or from excessive dilatation with water or air in intussusception.

Viciously introduced objects also may lacerate both anus and rectum or vagina. Wounds complicated with injury of the peritoneum or surrounding organs are often fatal from hemorrhage or from sepsis.

Treatment.—Incised wounds should be asepticized and sutured. Lacerated wounds can sometimes be treated in the same manner; others must be drained. If the bladder has also been injured, perineal cystotomy may be required. If the wound extends to the peritoneum, a celiotomy should be done at once and the wound in the peritoneum closed.

FOREIGN BODIES IN THE RECTUM.

Foreign bodies may be introduced into the rectum either by accident or design, or may descend from the intestine. Fishbones, irregular-shaped articles, jackstones, enteroliths, and large scybalous masses may become arrested at the sphincter. Pain, ineffectual attempts at defecation, straining, and blood should always cause the surgeon to examine the rectum with his finger.

Treatment.—The history of the case will often be deceptive, especially with vicious large boys and girls.[1] Under anesthesia the sphincter should be dilated, and if finger and forceps fail to remove the article a large uterine bivalve speculum should be used, or a large cylindrical speculum to protect the walls and to inclose the object.

PROCTOTOMY.—External proctotomy, by opening the rectum posteriorly, should be practised if the object cannot be removed through the anus.

If subsequent ulceration of the rectum occurs, silver nitrate should be applied and the rectum dilated with bougies to prevent stricture.

[1] Poulet, Foreign Bodies, i, 219.

CHAPTER V.

GERY OF THE GENITO-URINARY ORGANS.

TAL DEFECTS OF THE GENITO-URINARY ORGANS.

IATIONS and defects of the sexual organs demand the most tention of the surgeon, since any departure from the normal lers its possessor liable to ridicule and morbid sensitiveness lancholy or even insanity. The psychic influences governing procreation are most profound and mandatory, influencing l female from an early age, and if allowed to become abnormal d, may end in mental, moral, and physical degeneration. so slight that it may be but a blemish, as even a simple hydro- exaggerated to greatly undue importance and deter from

deformities are not productive of pain, relief is liable to be ss parents are judiciously advised by the surgeon.

Operation.—When there is no necessity for immediate inter- should be allowed to pass the period of infantile dangers, but hree to five, before associating with other boys, every possible tific surgery should be applied to bring his organs as nearly as ne normal (see Hypospadia, Epispadia, Exstrophy, p. 175). tion is impossible, the child should be unsexed at an early age. m the effect upon animals and upon eunuchs, the individual will be a happier and more useful member of society, will mental and moral degradation so common in this class,[1] and n possible insanity; results that more than compensate for k in physical development.

DISEASES OF GIRLS.

of the sexual organs in girls should receive careful attention health and happiness of the individual is largely dependent nal conditions of these organs. By these organs her future life lominated, since child-bearing is the primal object of her ex- n while the generative organs are in their developmental e unfortunately subject to some of the diseases of ovaries and e found in adults. Ovarian and dermoid cysts, sarcoma, and re found even in the early years of life, and in older girls, lpingitis may be present.[2] Early sexual development and ruation occasionally occur even in infancy.

Keating's Cyclo. Dis. of Children, iii, 633–673; Archives Pediatrics, 1886, 20.

eating's Cyclo. Dis. of Children, iii, 731.

In infancy and in young girls the generative organs are undeveloped and the parts are chiefly urinary in function. In fact, throughout life the so-called genito-urinary organs are entirely independent systems save in their proximity and in the use of some of the same tubes for conveyance of secretions.

PELVIC EXAMINATION in small girls is best accomplished by the rectum, as the vagina is too small to permit satisfactory exploration. Under ether and with slow and gentle introduction of the finger through the anus, the whole pelvis can be reached, uterus, ovaries and tubes investigated, and their absence or diseased condition recognized. The relatively large size of the infantile cervix must not be taken for an abnormal growth (Fig. 115), and in exploration to determine the sex in pseudohermaphrodites, the prostate and intrapelvic testicles should not be mistaken for uterus and ovaries. Bimanual palpation under ether is helpful in diagnosis. The surgical treatment of pelvic growths in girls does not differ materially from similar conditions in adults and need not here be discussed.

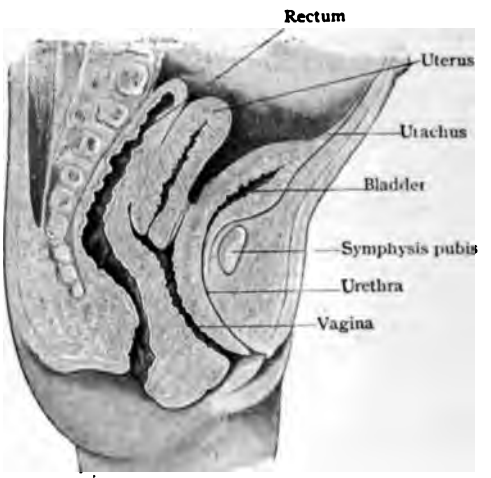

FIG. 115. — Sagittal section through pelvis of new-born female child, hardened in formalin, showing infantile form and suprapubic position of bladder. (Piersol's Anatomy)

Germ Defect. — Hereditary germ defect, arrest of development, non-union, displacement of embryonal structures, traumatic and other causes, may result in deformation of the sexual organs in girls, although not as frequently as in boys. The Fallopian tubes, uterus, and vagina are developed from the ducts of Müller. The coalescence of the lower portion with disappearance of the septum produces a single tube from which is formed the uterus and vagina, while the upper portion forms the right and left Fallopian tubes.

Absent and Rudimentary Organs.—Absent and rudimentary uterus, ovaries, or vagina frequently pass undiscovered until puberty, except in the case of pseudohermaphrodites. The non-appearance of the menses and the lack of development of mammæ, pubic hair and pelvis usually lead to an investigation of the cause. Diagnosis of the absence of these essential organs is important before the contraction of an engagement preceding marriage. The author has seen most unhappy results from a neglect of investigation in the absence of menstruation. In one case a marriage was obliged to be forbidden almost at its consummation. An ignorant surgeon, not recognizing the total absence of uterus, had placed the girl in this unfortunate position by professing to form a vagina, but had in reality slit her urethra from meatus to bladder and left her with urine dribbling from the pouch.

Unequal or maldevelopment of the ducts of Müller may result in DOUBLE ORGANS, which may be separately impregnated. There may also be a DOUBLE VAGINA. The rectum or the bladder sometimes opens into the vagina.

RFORATE HYMEN and a CRIBRIFORM[1] hymen are occasionally
he hymen is not a simple fold of mucous membrane, it is the
ty of the vagina. Its imperforate condition is usually undis-
menses are retained or until marriage. The defect is readily
ial incisions, followed by dilatation with vulcanite bougies.
VAGINÆ is a closure of the tube at any point which may later
enstrual flow and require operation. This plastic operation
luctive of extremely high mortality from sepsis.
TAL ADHESION OF LABIA is occasionally encountered. The lips
asily separated by traction outward with the thumbs or by
ent, and re-adhesion is prevented by a light gauze or cotton
l with petrolatum.

r Thrush of the Vulva.—Thrush in young girls is due to the
e *Oidium albicans* and is similar to the affection in the mouth.
ected by cleanliness, the application of a saturated solution of
te to the ulcer and tampons of boroglyceride.

Vulvæ.—ITCHING OF THE VULVA is usually due to an irritating
s with discharge, but may be caused by vesical calculus,
ruptions, or nervous affections. It is sometimes so intense as
riation from scratching. The irritation and frequent handling
ay lead to masturbation. The discovery and removal of the
me importance. The hood of the clitoris should be freed, fol-
y cleansing, irrigation of the vagina with potassium perman-
n 1:1000, brushing the parts with a 2 per cent. solution of car-
a 2 per cent. solution of silver nitrate, followed by a stearate of
r a powder of bismuth subgallate. A very comforting appli-
e with calamine, zinc oxide, glycerine, alcohol, limewater, and
r. Carbolated zinc ointment with menthol, camphor, calomel,
also beneficial (Pruritus Ani, page 164).
ED LABIA should be retrenched and sutured, as they are liable
size later.
TAL CYSTS of the vaginal wall, as the result of a persistent
üllerian duct, are occasionally found, and may increase in size.
ccessfully dissected such a cyst from the anterior vaginal wall
y to the bladder.
THE VULVA in young girls is usually due to the presence of
ffler bacillus and should be treated by the application of a 2
tion of silver nitrate and the hypodermic administration of
ntitoxin.

Hood or Prepuce of the Clitoris.—If signs of nervous exci-
irritation arise in masturbating girls, the fold covering the
be released by a probe, followed by careful attention to clean-
atment of the skin irritation (see Pruritus Vulvæ, above).
strap of an extension hip splint with too short pelvic bands
pass up between the labia.
RGED CLITORIS should not be removed in pseudohermaphro-
he sex is positively determined by the discovery of a uterus
nd by menstruation.

[1] Marshall, Keating's Cyclop. Dis. Chil., iii, 741.

Wounds of Urethra and Vagina.—Urethral and vaginal wounds in girls may be caused by falling upon sharp objects, by lewd manipulations, or by lacerations in young children, or from forcible violation by a villain whom to call beastly is to cast a disgrace upon the superior animal.

If the urethra is torn it should be carefully sutured under ether with chromicized gut, the labia and vagina repaired, thoroughly irrigated with silver nitrate or argyrol solution to avert germicidal infection, and occasional aseptic irrigations practised. A catheter may be worn for a few days or the urethra may be supported by a finger during urination.

FIG. 116.—Fatty tumor of vulva.

Vulvar Lipomata.—Fatty tumors of the labia occasionally develop in early life (Fig. 116). They are readily removed, but care must be taken to protect the wound from urine by closing it with collodion and covering with rubber adhesive plaster.

GONORRHEAL VAGINITIS IN CHILDREN.

GONORRHEAL VAGINITIS in a girls' hospital ward is one of the most obstinate and vexatious of infections, defying for months as it often does the most energetic means of extirpation. Absolute and long-continued quarantine of nurses and of infected children is often necessary. Diapers, towels, gauze, clothing, toys, water closets, baths, syringes, or the slightest carelessness on the part of nurses or of a single child, may spread the infection. Every girl must be examined before admission and frequently thereafter by a competent physician, and cultures made of the moisture found about the vulva and vagina. The absence of the gonococcus of Neisser at one examination is not always a certain test. The acid-forming bacillus of Doderlein frequently does not destroy the gonococci if they are in large numbers (Fig. 117).

In either gonococcic or pneumococcic infection of the vagina the child may carry the infection to her conjunctiva by finger. In infants this condition may be contracted during passage through a foul vagina or from older children, or by sleeping in bed with infected father or mother, or by wearing infected clothing. In older girls, direct cohabitation is often the cause.

The discharge will be moderately yellow or yellowish green, with redness of labia and thighs and light adhesions of labia.[1] The clinical diagnosis can be confirmed in the laboratory. In simple catarrhal vaginitis there may be many bacteria and but few diplococci; in gonorrhea, many diplococci in pus-cells which are discolored by Gram's stain. The diagnosis from pneumococci and other diplococci is often difficult.

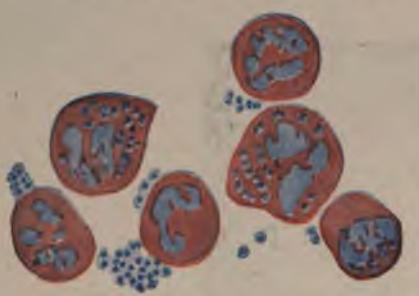

FIG. 117.—Pus from a vulvovaginal gonorrhea. Stained according to May-Grünwald. (Pfaundler and Schlossmann.)

Small boys may contract gonorrhea from vicious nurses, or by using utensils of infected individuals. Older boys become infected from cohabitation.

In GONORRHEAL VAGINITIS, absolute isolation of the child and nurse is necessary. Burning, or separate washing of clothing after disinfection with strong carbolated solution, the constant protection of the vulva with borated gauze, vigilant cleanliness, and the irrigation of the vagina are essential. A germicidal argyrol or other silver solution, or a 1:9000 solution of corrosive sublimate should be carefully injected, but in very young children it is advisable only to scrupulously but gently cleanse the external genitals.

In an acute gonorrheal infection following rape, the child should be etherized, the vagina thoroughly irrigated, and every portion mopped with a 2 per cent. solution of silver nitrate or copper sulphate, or argyrol 5 to 25 per cent., or protargol 1 to 10 per cent. The vaginal walls should then be separated by gauze soaked in boroglyceride or carbolated oil, or glycerine and tannin, or other astringent. Argyrol and all washes of silver salts stain the clothing. Later boric acid solutions are best.

Gonococcic vaccine therapy[2] controlled by the opsonic index has been successfully employed, but the close observation of clinical symptoms is more important.

Gonorrhea from direct contact is fully treated in works on venereal diseases.

VULVOVAGINITIS in childhood not infrequently leads to disease of the uterus, tubes, or ovaries, hence any case of protracted leucorrhea (fluor albus) should receive careful investigation and treatment. The traumatism of rape will produce a vulvovaginitis even if gonorrhea is not communicated.

SIMPLE CATARRHAL VAGINITIS is usually due to anemia and constipation with uncleanliness. The discharge is often irritating and may lead to much rubbing of the parts and to masturbation.

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[1] Holt, Diseases Infants and Children, 1906, 689; New York Med. Jour., Mar., 1905

[2] Butler Churchill, Amer. Med. Assoc., 1908, Section Diseases of Children.

A vaginitis occurring during convalescence from exanthematous or other disease, anemia, or tuberculosis should be treated by a life in the open air, nutritious food and general tonics. Intestinal disorders will require minute doses of bichloride of mercury with pepsin. The bowels should be regulated by fruit and by gluten suppositories. The genitals should be kept scrupulously clean and anointed with carbolated white petrolatum, or dusted with stearate of zinc. Vaginal suppositories are often more convenient than injections of alum, borax, or potassium permanganate. The suppositories may contain tannin, boroglyceride, or acetate of lead.

CONGENITAL MALFORMATIONS IN BOYS.

DOUBLE PENIS is rare except when associated with other abnormalities.

HYPERTROPHIED PENIS is sometimes present in imbeciles and in children with spinal paraplegia.

WEBBED PENIS should be early separated from the scrotum and the organ covered with skin.

ABSENT OR DIMINUTIVE OR RUDIMENTARY PENIS.—The penis may be entirely absent, or concealed or diminutive (Fig. 118). When concealed in the mons or scrotum it should be released by incision and an integumentary covering provided by flaps from neighboring tissues. When covered with a large preputial hood, this fold should be stripped from the glans or circumcised to allow for better development. When partially buried, the organ may be released by plastic operation and then elongated during infancy by gentle stretchings.[1] INFANTILE PENIS (micropenis) is sometimes persistent and becomes a magnified source of anxiety to adolescents. Enlargement usually takes place after puberty.

FIG. 118.—Diminutive penis in adolescent.

Frequent or continued erections of the penis—PRIAPISM—in childhood are often the result of vesical calculus, or preputial contraction, or worms, or spinal irritation, or paraplegia. The cause may be discovered and removed. Freeing of the prepuce, crushing of a stone, or clearing the rectum will usually bring normal conditions. The spinal caries cases are the most serious.

ABSENT BLADDER.—In malformations of the urinary organs resulting in a defective or absent bladder, the ureters may empty into the rectum or urethra, or may discharge at the umbilicus. The ureters may be dilated to become reservoirs by the application of a pad at their orifices, or the ureters may be implanted into the sigmoid, or a new bladder constructed (Exstrophy, p. 182).

[1] Willard, Malformations Genito-Urinary Organs, Keating's Cyclop. Dis. Chil., 1890, iii, 633.

BLADDER.—A supernumerary bladder, with or without double
ceedingly rare, but a stone has been crushed in one bladder
r remained healthy. Unless serious trouble arises, the removal
se bladders through an abdominal operation would not be

SCROTUM.—The scrotum is rarely absent, except in total non-
ll the genitalia, anus, and rectum.
CROTUM often coexists with hypospadias and spurious herma-
. 188).
NITAL DIVERTICULUM of the urethra consists of a pouch upon
face of the canal, produced by a failure of the glandular and
ns of the tube to properly unite. The pouch distends with
eadily recognized.
nt from the walls of the sac should be excised over a catheter,
ue being retained to reconstruct the urethral tube with fine
utures. A retained catheter in young children is seldom ad-
he urethra should be supported by the finger during urination.

CONGENITAL URETHRAL FISTULA.

ection with hypospadia should be considered congenital
la, which may arise from imperfect closure of the urethral
e urogenital sinus, or from an intra-uterine rupture of the
an imperforate meatus. Imperfect fusion of the Wolffian
ie ducts of Müller causes many anomalies in both male and
l organs.
ethra is present in front of such a fistulous opening, its clo-
d it does not take place spontaneously after birth, can be
a plastic operation, as in penile hypospadias (p. 176).
urethral fistula in boys is ordinarily the result of traumatism.
rhaphy and Urethroplasty.—URETHRORRHAPHY is employed
t exceeding one-quarter of an inch in length. Over a steel
ges of the defect are pared. With the finest oiled catgut and
ound straight needle the connective and submucous tissues are
errupted sutures, and the skin sutured separately with black
icized gut. The part is covered with collodion and the cath-
as long as it does not irritate (Catheterism, p. 191).
pening may sometimes be closed by frequent touchings with
dine.
PLASTY.—Flaps may be raised laterally, slid inward with
against the catheter and united at the median line, leaving
to granulate on either side; or a flap may be folded upon its
bove or laterally, and sutured with its skin surface toward
y tucking its margin beneath a flap raised from the opposite
ap is superimposed upon its raw surface. The scrotal or the
may be utilized if necessary.
s, Delpech's, or other operation is sometimes successful in
fect.

In subsequent urinations, the cicatrix should be supported by the finger. The occasional passage of a steel sound will prevent cicatricial stricture. In case of failure, a temporary perineal opening should be made to drain the urine while a second operation is performed.

HYPOSPADIA.

A hypospadia (ὑπο under, and σπάω to open) is a congenital abnormal opening in the lower surface of the urethra at any point between the end of the glans and the prostatic portion of the urethra. It is the result of failure of the lateral halves of the penis to unite in the median line. The MALE sexual organs originate from the Wolffian body and ducts; the FEMALE from the Müllerian ducts. An exto-endoblastic structure forms the CLOACAL MEMBRANE. During the fourth week the URGENITAL SINUS[1] is noted. In the second month, the lower part of the sac produces the posterior urethra in the male. The anterior division of the embryonal pouch results in the formation of the genito-urinary organs, the posterior in the lower intestines. The GENITAL TUBERCLE forms the penis in boys, the clitoris in girls. At the end of the second month of fetal life the genital system is represented by the Wolffian body and the vesical dilatation of the allantois. The sexual evidences of the external genitals are still indistinct, being represented by the genital eminences, folds, and ridges; the cloaca has, however, separated into rectal and genito-urinary divisions, the division being completed during the tenth week. Sexual distinction is present by the end of the third month, the penis and prepuce of the clitoris becoming more positive in the fourth month. The prostatic and membranous portions of the urethra are developed from prolongations of the UROGENITAL SINUS, while the penile and balanitic portions are formed from the GENITAL TUBERCLE. Accompanying deformities of the genital organs often cause pseudohermaphroditism and confusion as to sex, especially when the scrotum is cleft and the testes have not descended. The vulvar type of conformation in hypospadic males is common, owing to an arrested development of the inferior genital buds at the time when differentiation of sex takes place.

This deformity may extend through several generations.

A hypospadic opening may be just behind the glans (BALANITIC) or in the body of the organ (PENILE) or in the scrotum or perineum (Fig. 119). The urethra in front of the opening is present only in rare instances, probably due to rupture of the urethra in fetal life, as the kidneys are said to secrete urine in utero. If the opening is in the glans or anterior urethra, fertile cohabitation will be possible if there is not so much incurvation of the penis during erection as to cause emission outside the vagina. This can be partially corrected by traction on the dorsum during coition. In the penile variety, fecundation is difficult or impossible. In the scrotal and perineal forms, the patient is incompetent to deposit the semen within the vagina and should not marry. A perineal opening also renders urination most inconvenient except in the position assumed by females.

[1] Piersol's Anatomy, 1696.

Operation.—The tiny penis of a small child is difficult to operate upon and until the first years of life are passed it is unwise to interfere. Before the child mingles with his fellows, however, by the age of five or six an attempt should be made to close the opening and spare him from mortification, if the deformity is noticeable. It is of course easier to operate upon the larger penis of an adolescent when his coöperation can be secured, but the mental effect of secretiveness from companions produced by delay will prove mentally and morally injurious to the lad. The parents should be warned that several operations will be necessary to complete the cure, as the parts are thin and the presence of urine unavoidable. Necessary delays between operations may occupy months and unlimited patience will be required. Large boys and young men realizing the obstacle to marriage will submit themselves to much discomfort. If a scrotal hypo-

FIG. 119.—Hypospadia with scrotal opening and gutter along under surface of penis. (Pfaundler and Schlossmann.)

spadic male has been rash enough to marry, he should undoubtedly submit to operation. Fertilization can sometimes be accomplished by a mechanical appliance that will convey the semen into the vagina or an intra-uterine injection of semen can be made.

Operative procedures include:

(1) Straightening the incurved penis; (2) formation of a urethra; (3) final closure of the hypospadic opening.

In all plastics of the penis, the chief difficulties will arise from the shortened condition of the corpus spongiosum. This is often so short that the penis is held in close apposition to the scrotum, of course preventing fertile coition.

1. STRAIGHTENING OF THE INCURVED PENIS.—A transverse incision through the sheath of the corpora cavernosa is necessary, sometimes entirely through the median septum nearly to the dorsum. The penis is then stretched and straightened and into this gap should be sutured lateral flaps of skin or a flap drawn from the excessive preputial fold. Collodion along the length of the dorsum will assist in maintaining position even during erections or the penis may be sheathed in adhesive plaster. After the incur-

vation has been corrected and healed, the new urethra must be constructed.

2. Formation of a Urethra.—In the balanitic variety the defect may be arrested by laying off lateral skin flaps, exposing and dissecting free the semblance of a urethra for some distance back of the opening (Fig. 120). With a bistoury or a punch, a channel is then made from the abnormal meatus to a point in the dorsal aspect of the tip of the flexed glans. Through this channel the newly formed urethral tube is drawn and sutured at the extremity. The skin flaps are then sutured in place (Fig. 121).

It is difficult in the firm tissue of the glans to construct a satisfactory urethral canal unless a good gutter already exists. When the corpus spongiosum is short and the penis incurved, a better meatus can be secured

Fig. 120.—*A*, incisions for formation of skin flaps; *B*, tunnelling of glans penis. (Beck.)

by thus tunnelling the glans and making the new meatus on the dorsal surface of the tip, thus bringing the ejaculation of urine and of semen into more favorable position (Fig. 121).

The method of Thiersh forms the urethral tube by making deep converging incisions through three-fourths the thickness of the glans along each side of the urethral gutter. After freshening a narrow surface on the outer side of the incisions, the raw surfaces are brought together over a catheter and sutured in position.

Another method for the penile portion gives a double thickness of flap that is helpful. A long wide flap is raised from one side of the urethral gutter, with transverse incisions at the ends, and dissected from without toward the median line. On the other side the longitudinal incision is made parallel to the gutter but only as far outside of it as is needed to make the border for stitching to the opposite flap to form the new tube. This latter flap is dissected away from the median line. The

first flap is now reversed with its skin face inward and sutured to the opposite side over a catheter. The second flap is applied with its raw surface upon the raw surface of the first flap, and sutured along the margin with catgut or iron-dyed silk anointed with carbolated cosmoline. Quilled sutures, shotted lead strips and silver wire have the advantage of acting as splints.

The operations of Nove-Josserand and Rochet promise hope of success. A transverse incision is made in front of the abnormal opening, from the extremities of which long incisions are made backward, parallel to and well outside of the sides of the urethra but not opening it. The skin is then dissected up from the sides toward the median line and the flap is

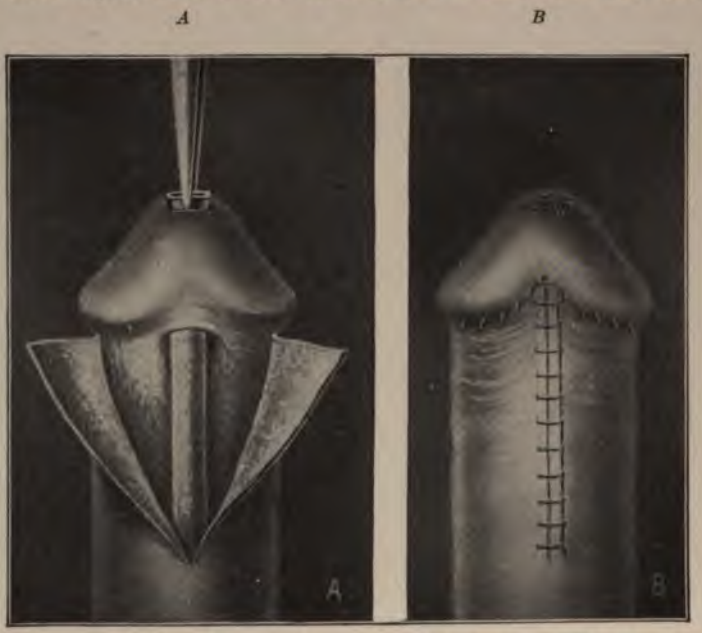

FIG. 121.—*A*, new urethra drawn through the extremity of the glans penis; *B*, new urethra sutured in place and covered with skin flaps. (Beck.)

inverted, skin inward, around a soft catheter and neatly made into a tube with catgut sutures. The posterior sutures of black silk are left long as tractors and are threaded on a needle and stitched around a rubber catheter. The catheter with its enveloping tube is then doubled upon itself and drawn by a slender pair of toothed forceps through a tunnel cut through the penis to the dorsal extremity at its very tip (Fig. 122). The new urethral tube is then sutured to the glans and the posterior end of the catheter pushed into the bladder and retained during healing. The new urethra is united to the original tube at a subsequent operation.[1]

Duplay's method necessitates three or four operations with many months of time. For the penile portion of the plastic, four long longitudinal flaps are formed. The two inner ones are sutured with catgut with SKIN

[1] Willard, Keating's Encyclo. Dis. Chil., iii, 657; and Supplement 1900, 860; Archives Pediatrics, 1886, 193, 385.

SURFACES INWARD, partially enclosing a catheter, or, if tissues permit, entirely enclosing it. The two outer flaps are dissected far back and applied with their raw surfaces upon the raw surfaces of the inner flaps and these sutured with oiled iron-dyed silk. The catheter is retained in the bladder as long as it is well borne.

Another operation is made by a cross incision at the base of the glans and deep incisions far out to the sides which permit a flap to be dissected back to and around the abnormal opening, forming a sac like that of a hernia. By stitching with catgut around a catheter a tube can be constructed, which tube can be plaited and then drawn forward through a tunnelled perforated glans and sutured. C. H. Mayo and Van Hook

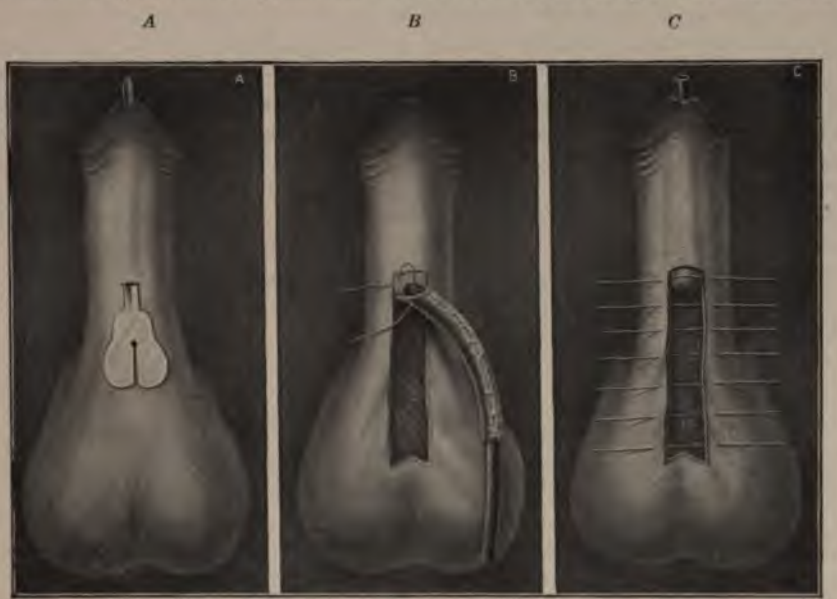

FIG. 122.—*A*, tunnelling of penis and glans; *B*, formation of a tube around a catheter; *C*, new urethral tube reversed and carried with catheter through a tunnel to the tip of the penis. (Rochet.)

borrow tissues from the dorsal surface of the penis.[1] Gouley's, Szymanowski's and other operations are also useful.[2]

3. FINAL CLOSURE OF THE HYPOSPADIC ORIFICE.—When a urethral canal has been secured in front of the opening by some form of plastic, the anterior and posterior urethras may be joined by a final plastic closure, paring the edges thoroughly at the opening and turning in a double flap over a catheter to close the defect. The catheter should remain in the bladder as long as it does not irritate. An external perineal urethrotomy is helpful in temporarily diverting the stream of urine.

After Treatment.—As it is practically impossible to retain any dressing on small children unless held by adhesive plaster, it is wiser to paint the line of the wound with compound tincture of benzoin and apply a large pad of borated cotton held in place with a diaper. If older, the patient

[1] Jour. Am. Med. Assoc., Apr. 27, 1901.
[2] Trans. Urological Soc., 1907; New York Med. Jour., 1908.

ught to urinate slowly, to support the wound with a finger, n in bed to avoid friction. The parts may be cleansed by c acid solution to flow over them after each soiling. The ld be closely watched and removed if irritating. Iron-dyed easily found but in young children chromicized gut may be r boys a soft catheter may be retained for several days. Erec- be prevented by suppositories of opium and lupulin and the n of bromides. After the final closure, the boy, if old enough, ntle pressure with a finger during urination, support the delicate for several weeks.

.—While the preputial and scrotal tissues are not as valuable hose obtained from the body of the penis, yet the preputial not be sacrificed until the completion of the cure after all cedures, as its tissues may become necessary for the plastic sometimes be utilized by carrying the glans through a button- ntre and employing one-half the thickness as a flap with two ch pedicles can be cut loose later. In perineal and scrotal loose tissues of the scrotum can be utilized for plastic flaps. es pinning the penis to a thin board to facilitate paring and large boys, subsequent contraction of the urethra may be the passage of sounds. The most common cause of failure nsufficiency of flaps with too great consequent tension from

EPISPADIA.

adic congenital malformation, the corpora cavernosa of the arated and the urethra exists as a gutter upon the dorsum a tube beneath. This vice of conformation is due to hereditary m, or to intra-uterine injury of formative cells. Failure of n advancement in the development of external and internal cles, and irregularity of control result not only in superim- ethra upon the corpora cavernosa but also in other coexistent s, as exstrophy of the bladder, pubic fissure, distorted penis, cryptorchidism. The broad flattened penis sometimes lies abdominal wall, partially covering the bladder exstrophy. deformities often cause confusion as to sex (see Exstrophy rodism, p. 188) if the testicles have not descended. As an trophic male is NOT CAPABLE OF PROCREATION, it is wiser him when young, thus saving him from the usual mental and ation (p. 168).

n.—Plastic operations are even more uncertain than in hypo- the commonly associated exstrophy of the bladder seriously he procedure.[1]

all proposed plastic operations have failed to secure a sphincter r sufficient to control the flow of urine except for a short e. The best that can be accomplished is to carry the point it sufficiently forward and to the lower side of the penis to

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[1] Keating's Cyclo. Dis. Chil., iii, 658 and vi, 861; Arch. Pediatrics, 1886, 193, 385.

permit of the more accurate adaptation of some form of portable receptacle (Fig. 123). All operations for epispadias and exstrophy have proven both tedious and unsatisfactory, but if control of urine is secured, such results should be considered as successful. The most serious difficulty in the way of any plastic operation for this deformity is to secure a sphincter that will control this incontinence which debars the individual from employment or pleasure. When the bladder is not extroverted, Beck[1] advises the dissection of a large wide longitudinal area from the abnormal dorsal groove. The incision is continued around the malformed urethral opening and carried far up above the projecting abdominal fold. Dissection is made upon a catheter as a guide until sufficient tissue is secured, after which a transverse incision behind the glans connecting the two longitudinal incisions completes the flap (which resembles a dissected hernial sac), the neck of the bladder being at the base. This sac is sutured over the catheter into the FORM OF A TUBE. The body and glans are then perforated with a bistoury and slender grasping forceps are carefully carried through the new tunnel, after which catheter and new sac-like urethra are together pulled through the opening and the skin sutured over the catheter along the under surface to the tip of the glans. The redundant prepuce may be utilized for lateral skin flaps to prevent contraction and to lengthen the penis. This operation has the advantage of giving an exit for the urine at the tip of the penis, lengthens the organ, and facilitates the adaptation of a portable urinal.

Scrotal or preputial flaps can later be utilized to close remaining defects. Nélaton's plan of borrowing skin from the abdomen would only be serviceable in the absence of exstrophy, and even if pubic hair-bulbs are primarily destroyed, subsequent difficulties are likely to arise. The raising of a flap from the skin of the scrotum and passing the penis through a buttonhole yields an improved tube. The raw surface of the flap is applied to two longitudinal raw surfaces on the dorsum, a strip of skin being left along the median urethral gutter.

Thiersh's plan requires four operations and many months. The first stage contemplates the formation of a meatus and the closure of the balanitic region; the second, the construction of the penile urethra; the third, the buttonholing of the prepuce and plastic closure of the extremity of the tube; the fourth, the closure of the bladder opening at the base of the penis and connection of the bladder with the constructed urethra. Its feasibility will depend upon the amount of deformity in penis and in bladder.

Duplay also divides his operation into four stages, with practically similar steps to those adopted for hypospadias.

When accompanied by exstrophy of the bladder, as is usually the case, implantation of the orifices of the ureters together with the adjoining bladder wall into sigmoid or rectum (Maydl), or into the loin (Bottomley), is of service. (For further operative details see Bryant's or Binnie's Operative Surgeries.)

[1] New York Med. Record, Mar. 30, 1907.

EXSTROPHY OF BLADDER.

Ectopia vesicæ; extroversion; hiatus of the abdominal wall.

y of the bladder is fortunately of very infrequent occurrence, es being recorded in 116,000 births. It is so disgusting a t it debars the sufferer from all pleasure in associating with nd it is encouraging to know that two-thirds of the victims onephritis before reaching adult life.

t unfortunate malformation is produced by failure of the inal plates to unite in the median line, resulting in absence r wall of the bladder and protrusion of the posterior wall as a s bearing the exposed orifices of the two ureters (Fig. 125). has been explained as the result of pressure upon the pubes mbilical cord passing between the legs of the fetus. The development being interrupted, the posterior bladder wall unites with the abdominal plates by slow cicatrization. Nearly all of the cases occur in males and are accompanied by epispadias (p. 180) and often by fissure of the pubic bone, cleft scrotum, and by other defects that render the question of sex uncertain (see Hermaphroditism, p. 188). The prostate is often absent and double hernia present. In females, a common cloaca may represent vagina, rectum and bladder, but if uterus and ovaries exist, impregnation would be possible. The ever present odor of decomposing urine soiling the clothes, with the irritation of the exposed bladder and the exclusion from respectable society serve to degenerate such a patient both mentally and morally and to convert him into a sexual pervert. There is no record of an exstrophic epispadic male having been fertile, as the penis is always dwarfed and deformed.[1] The testicles, if present, should therefore be removed at the time of the plastic s relieving an important degenerative impulse (p. 168).

able urinal.

fancy, the exposed mucous wall must be protected by pads ze or cotton and great care exercised in regard to cleanliness; water, petrolatum, stearate of zinc, etc., are to be used freely. nts, both before and after operation, a rubber urinal should eive as much as possible of the urine (Fig. 123).

minary to operation Greig Smith's plan of retaining a patient back is certainly worthy of the trial. He testifies that under t and protection of the bladder with dextrin and oiled silk, a short time cutification of the upper portion of the exposed to the ureteral openings.

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nnals of Surg., Apr., 1899, 497; Keating's Cyclop. Dis. Chil., iii, 658, and Pediatrics, 1886.

Operative Treatment.—Operative interference is indicated as soon as the child has passed the diaper-wearing period, not later than two or three years.

(1) Plastic operations to complete the imperfect bladder by formation of an anterior wall with flaps taken from the abdomen, thighs, or scrotum, or by a separated loop of intestine.

(2) Transplantation of the ureters into rectum or sigmoid or vagina or urethra or loin, with or without the trigonal orifices.

(3) Osteotomy of ilium from crest to sacro-iliac foramen and forcible approximation of deficient pubes.

(4) Nephrostomy.

(1) Plastic Closure of the Abdominal Opening.—The operation of plastic closure has been attempted in various ways, but while the bladder wall can be covered, urinary continence is rarely secured and the use of a portable urinal is still necessary, since the formation of a sphincter is impossible; temporary damming of the fluid is sometimes secured. Several operations are ordinarily required and many months consumed before even partially satisfactory results are secured, *i.e.*, a reservoir that will retain urine for several hours (Fig. 124). Flaps may be secured from the abdomen above or from the sides, or from the groins or scrotum. They may be applied reverted with skin face inward and lateral flaps superimposed upon the raw surface, or raw surfaces may be applied to the freshened edges of the bladder. Some surgeons permit the loosened flap of skin to lie in the groin enclosed in gauze for ten days until its raw surface becomes covered with epithelium, after which it is placed in position.

Fig. 124.—A result of plastic operation for exstrophy of the bladder. An opening still exists at the lower angle. The white area resembling a penis is due to the deposition of urinary salts. Inguinal hernia exists on both sides.

The author secured a fairly satisfactory plastic result in a child five years of age with absence of abdominal and anterior vesical wall, clubbed epispadic penis and cleft of the pubes two inches in width[1] (Fig. 125). An inverted U-shaped flap was cut from the abdominal wall nearly as high as the epigastrium, one-fourth wider than the bladder in order to allow for shrinkage. Reversed and folded downward upon its base with skin surface inward, it more than covered the exposed bladder surface without tension on the sutures. One-quarter of an inch outside the lower and lateral margins of the opening, an undercutting incision raised skin and fatty tissue and into this crevice was tucked the edges of the reverted flap with raw face outward. Chromicized gut stitches extending through fat, connective tissue and under layer of the derm (but not including the epiderm) anchored the flap firmly, thus slightly inverting the edges of the skin and holding the two raw surfaces in apposition. A continuous circumferential

[1] Willard, Ann. Surg., xxix, 1899, 497; Tr. Phila. Acad. Surg., i, 134.

suture added to the support. The raw face of the reverted flap was then covered by the raw face of two lateral flaps drawn in from pubes and groins on either side (Fig. 126). Under-cutting incisions and sutures readily closed the raw surface in the upper abdomen at the median line and the two lower flaps were sutured. The wound was kept covered with an eighth of one per cent. sclution of formalin, the gauze being changed as often as soiled. No leakage occurred through the stitch holes and the opening of exit at the bottom was narrowed to one-fourth of an inch in diameter, against which opening the stunted penis could be pressed as a stopper. Several ounces of urine could be retained (Fig. 127).

Greig Smith, Maury, Wood, Gibson, Bigelow, Thiersh, Segond, Pousson, Billroth, Berg and many others have devised various methods but with indifferent results.[1] All such flaps should be larger than the defect

FIG. 125.—Exstrophy of the bladder with flat epispadic penis (see Fig. 126).

FIG. 126.—Flaps from above and from the sides sutured over exstrophy (see Fig. 125).

to be covered, in order to allow for contraction, and the base should be planned to give good arterial supply. One disadvantage of flaps with skin turned inward is the growth of hairs in the bladder and their subsequent incrustation. The hood of a hypospadic or epispadic penis may be utilized for flaps. The infectious character of the irritated mucous membrane may be altered by preliminary silver nitrate treatment.

(2) URETERAL IMPLANTATION. — Pyelonephritis from infection of the kidneys is, of course, the most serious complication in all operations where the bowel is employed as a reservoir. This result is likely to finally occur in a large percentage of the cases of implantation. The question of kidney infection may be determined by ureteral catheterization. Hartley reports a mortality of 15 per cent. in forty-six cases.[2] Moynihan[3] has trans-

[1] As these are never emergency operations and are described in Operative Surgeries, space will not be taken for their technic. See Bryant's Operative Surgery, ii, 1151, also Binnie's Oper. Surg.

[2] Hartley, Ann. Surg., July, 1901, xxxiv, 25; Med. News, Aug. 29, 1903.

[3] Moynihan, Ann. Surg., Feb. 1906, xliii, 237.

planted the entire wall of the bladder. Rectal or sigmoid implantation of the ureter (ureterorectostomy) is the best procedure, but the prognosis is very unfavorable as to subsequent kidney infection. Maydl-Gersung's ureterotrigonal implantation of the orifice of the ureters[1] together with the surrounding bladder wall into the sigmoid or rectum offers the best hope of preventing ascending infection to the kidney. This intraperitoneal operation has been followed by 29 per cent. of mortality from peritonitis and shock. Infectious pyelonephritis however is not eliminated. Celiotomy is followed by extirpation of the bladder. In seventeen cases Lewis reports intestinal urinary continence for from three to seven hours

FIG. 127.—Absence of symphysis pubis in the exstrophic epispadic male shown in Fig. 125.

in all but two instances. Fowler reports a patient living and well nine years after implantation of the ureters into the rectum. He performed a median celiotomy, incised the posterior peritoneal layer, cut off the ureters and transferred them obliquely through the submucous and mucous tissues of a tongue-shaped flap lifted from the rectum. This flap and the course of the ureters through it evidently acted somewhat like the normal ureteral bladder valve.[2] Berg[3] advises operation at two or three periods as there is great danger of peritoneal infection from urine or feces in 10 to 20 per cent. of operations. When the ureter is too short to reach the sigmoid he

[1] Maydl, for bibliography see Ann. of Surg., xxxiv, 57, and Revue de Gyn. et de Chir., 1903, vii; Wien. med. Wochschr., xlvii, 28, 1896, and xxv, 25, 1894.

[2] Fowler, Treatise on Surgery, ii, 313.

[3] Berg, Surg., Gyn., and Obst., Oct., 1907.

ion of the small intestine, using it as a splice to carry urine
d. The bladder, except the ureteral openings, is excised.
oid has been found to be the most suitable reservoir since it
retaining urine for several hours and of voluntarily expelling
s. The sphincter of the rectum is also efficient in securing
r several hours, unless proctitis occurs.
of the extraperitoneal operations is Buchanan's[1] ureteral
o the rectum, an operation that has been followed by only
. It is commenced by carrying a catheter into each ureter
de. A button of mucous membrane one centimetre in di-
en removed with the orifice of each ureter and the tube
for about four centimetres. The peritoneal cavity if injured
d the catheters withdrawn. A finger in the rectum pushes
o the bladder and a transverse incision permits cautious
til the rectal wall is reached. A pair of blunt forceps is
rough the anus and made to protrude below and behind
A small incision over the points permits them to seize the
ureteral rosette and draw it into the rectum and out of the
choring chromicized gut suture is placed in the membrane
ing the ureter and the button is withdrawn within the
loosely sutured. The other button is treated similarly by
l incision. The ureter must not be injured or kinked. The
ending ureteral infection of kidneys is great whether cases are
n or not.
y[2] contends that the loin is a more convenient position for
n of a receiving apparatus for the urine. He advises, there-
ing of the ureters upward into this position, followed by the
the bladder, but kidney infection is not avoided as infec-
oriated skin is probable.
ptation of an apparatus which will absolutely receive all
lt, either in perineum (Fig. 123, p. 182) or loin (Fig. 128).
AL GRAFT.—A section of ileum with attached mesentery
splanted and sutured with mucous face inward around the
e defect to form an anterior wall of the bladder. Ente-
performed and the abdominal wall closed over the defect.
OTOMY AND APPROXIMATION OF THE INNOMINATE BONES.—
o or more inches in the pubic bones has led Trendelenburg,
Kuster and others to divide the sacro-iliac synchondrosis or
or the pubes and to forcibly bring the pubic bones in apposi-
n and suture them together, and close the bladder defect by
These operations are severe, the mortality high from wound
the results imperfect, but Trendelenburg considers this
ined with a plastic flap superior to ureteral transplantation.
tic operation is best suited to young children before the
n X-ray will determine the amount of pubic separation. If

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full bibliography and description see Surg., Gyn., and Obstet., Feb.,

r. Med. Assoc., July 13, 1907, 141.
., Gyn., and Obstet., Oct., 1907; Practitioner, London, 1909, lxxxii, 450.

FIG. 128.—Portable urinal for loin fistulæ. (Loux.)

ne is freshened and wired it is liable to become infected from urine. An iron wedge may be inserted to keep the iliac gap gluteal vessels must be avoided (Fig. 127).

n's,[1] Peters',[2] Lendon's,[3] Bergenheim's and Pozzi's operations ccessful, a small button of vesical tissue with the ureteral ng transferred.

HROSTOMY. — Nephrostomy with permanent tube drainage off of the ureters has also been proposed.

reatment.—The child should be placed upon a gas-pipe bed) covered with canvas in two sections with opening opposite frame is placed on blocks and the urine is permitted to drop acle as fast as discharged. Retention of the hips in a warm ath is helpful. In either flap or anastomosis operation the e kept rigidly upon its back for several weeks, and crying should therefore have weeks of preparatory retention in this

HERMAPHRODITISM.

tiation of sex does not occur in fetal life until the ninth week, genital tubercle is developed as early as the fifth week. At riod the labioscrotal folds appear on either side of the GENITAL This tubercle develops in the female into the clitoris, the inner becoming the labia minora and the outer the labia majora, lvar cleft is produced from the UROGENITAL SINUS. At this a slight elevation of the penis or clitoris and a cleft below of l sinus. Later, the integumentary folds develop into the labia ite to form a scrotum. The sides of the urogenital canal pro- a minora, or, in the male, the urethra. The urethra is formed ual extension forward of the epithelial ridge of the cloacal ong the under surface of the genital tubercle. The lips of the ve unite to form the urethral canal. Faulty and unguided results in hypospadia or in epispadia. Heredity, traumatism, with central supervision of development, non-union or imper- tubular prolongation of the urogenital sinus, or deviations erfect union in any of these processes may give rise to mal- gans and produce confusion as to sex.[4]

n the vulvar type of conformation is the most common, it is of uncertainty, to baptize the individual as a boy until later s of sexual attraction and other characteristics have become

OHERMAPHRODITE is an individual whose sex is uncertain, to malformations of the genital organs or to the apparent rgans belonging to both sexes. A male infant with diminutive enis with urethral opening in the perineum, cleft scrotum and

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Jour. Amer. Med. Assoc., 1905, xlv, 890.

rit. Med. Jour., June 22, 1901.

Trans. Australian Med. Cong., 1901.

liography and discussion of hermaphroditism may be found in an article by Keating's Cyclopædia of Diseases of Children, iii, 668.

undescended testicles presents more evidences of vulvar conformation than does a female child with atresia vaginæ and elongated clitoris.

TRUE HERMAPHRODITISM, vera lateralis, probably never exists, although many apparent instances of such condition are recorded. When carefully examined, it will usually be found that the organs designated as a testicle and an ovary have really been a duplication of an ovary or of a testis, malplaced and deformed.

FIG. 129.—Plaster cast of a pseudohermaphroditic female with enlarged clitoris. There is no reason to believe that the organs labelled testes were not supernumerary ovaries. The patient menstruated and had feminine characteristics. (Sayre.)

Four ovaries occasionally exist, as seen in the specimen shown in Fig. 129, which is evidently taken from a female with enlarged clitoris; there is no evidence to show that the organs labelled "testes" are not simply supernumerary ovaries.[1] Spurious hermaphroditism is the rule. For instance, during an operation for hernia a child presenting the perfect external genitalia of a girl, had a supposed ovary removed from the hernial sac. This organ when examined proved to be a normal testicle. A hernia on the opposite side appeared later, which on operation was found also to contain a testicle. It was therefore deemed advisable to unsex the individual and permit him to remain a neutral. A small vagina was present, but no uterus or ovaries could be located (Fig. 130).

FIG. 130.—External genitals of a pseudohermaphrodite, from whom, during operations for hernia, two testicles were removed. Vulvar conformation is frequently seen in boys with hypospadia. (Stone.)

In another case, organs that were supposed to be a uterus and tubes were removed by operation from the reputed father of twin children. The masses were found to be testicles.[2]

A patient of the author's with diminutive penis,[3] cleft scrotum and perineal meatus (Fig. 118, p. 173), lived as a maid until at thirty his testicles descended, beard appeared and his sexual attractions turned toward females.

In after life these mentally perverted individuals are liable, from pecuniary motives or for the sake of notoriety, to greatly misrepresent actual conditions. A female with elongated clitoris, after having borne a

[1] Willard, Keating's Ency. Dis. of Children, iii, 667; Am. Jour. Obstet., 1887, 423.
[2] Surg. Gyn., and Obstet., Oct., 1907, 484.
[3] Willard, Tr. Phil. Obstet. Soc., 1872; Jour. Amer. Med. Assoc., v, 27, 1907, 1810.

readily pose as a man, and after marriage, with the aid of a lice, proclaim herself the father of an infant.[1] The statements nals" as to their power to occupy both relations, *i.e.*, father are certainly open to grave suspicion of exaggeration or in reports a pseudofemale husband who had borne a child, nowledged to have cohabited with a male.

SED or CROSSED hermaphroditism with excess of either male gans occasionally occurs.

nt.—Plastic surgery is capable to a certain degree of improving epispadias, etc., of unloosening a webbed penis, or of liberating en it is concealed, or of removing an elongated clitoris. The on, however, should not be performed until the question of sex sitively determined. Any operation that offers prospect of d be undertaken before the age of five years, for reasons e 168. When the malformations are so great as to preclude y of procreation it is wise surgery to unsex the patient at an both physical and moral reasons.

xamination per vaginam is practically impossible at birth, the an with caution, under ether, be introduced into the rectum nanual palpation much information can be gained. In boys, of a prostate and of intrapelvic testicles should not be mis- rus and ovaries.

WOUNDS OF THE PENIS AND URETHRA.

vounds of the penis from falling on glass or sharp objects give e hemorrhage. The dorsal or the frenal artery, if divided, l. Bleeding from the helicine arteries may be arrested by hot ce or alum or adrenalin or by pressure of the hand or by tight h borated gauze and adhesive strips. Hemorrhage having ed, catgut sutures should be inserted as necessary. Cocaine band around the penis will control the pain of suturing. The l be thoroughly disinfected and sterile borated gauze fastened e strips, leaving the meatus exposed. In infants, sterilized e held in place with a diaper. Dressings should be disturbed ly as possible, as healthy urine is not septic. Erections in ould be controlled by opium and lupulin suppositories with l salix nigra at night.

s is viciously severed, even entirely, the vascularity of the part n attempt should be made to save the organ by suturing both rnosa and urethra. The genital organs are a favorite site of e razor of the colored man.

vounds of the urethra should be sutured at once with chro- nserted into the submucous tissue and inverting the mucous A catheter may be retained in the bladder in these cases if it ve irritating. The cicatrix for two weeks must be supported during urination. The dressings must be thoroughly aseptic nd erections vigorously controlled.

[1] Willard, Amer. Jour. Obstet., 1876, ix, 501.

Catheterization.—In CRUSHES and TEARS OF THE PERINEAL URETHRA, as frequently happens from falling astride of a fence, it will be fortunate if the surgeon sees the boy before any extravasation of urine has taken place. He may then carry into the bladder a large silver catheter, the very long eye of which is closed during introduction by a spirally cut obturator (Fig. 136, p. 197) so as to ensure the absence of clotting of blood in the eye or tube.[1] This obturator is suddenly withdrawn after the bladder is entered, thus giving suction power. If clots obstruct the instrument, the obturator may be reintroduced and the tube cleared. If the surgeon is possessed of untiring patience and skilled manipulative experience and never allows the point of his catheter to be deviated from the median line he will avoid making a false passage. A metal catheter is better than a gum instrument

FIG. 131.—Method of obtaining urine for examination in a small boy: *A*, with adhesive plaster; *B*, with a bandage and test tube. (Pfaundler and Schlossmann.)

and in experienced hands is less likely to produce false passages since the position of its point can be definitely known. A filiform bougie is usually a delusion and a snare. The largest sized admissible catheter is both easier and safer.

The catheter and the hands of the surgeon must be thoroughly asepticized, the glans penis washed with boric solution, and a sterile oil or jelly lubricant employed.

Catheterization of a male infant requires an exceedingly small instrument and correspondingly great caution in introduction. For one unaccustomed to the operation, a very soft rubber instrument may be safest. A laboratory specimen of urine may be obtained as shown in Fig. 131.

To retain a soft catheter in the bladder of a child is a very difficult matter, even with adhesive plaster, and the irritation and traumatism from friction usually compels early removal.

[1] Willard, Blood Catheter, Phila. Med. Times, xvi, 853.

e wounds with extravasation the presence of a catheter in the
ie least of two evils, and it should be retained until signs of
tion are present. In tractable boys, the catheter may be with-
on as swelling has subsided if extravasation has not occurred
urethrotomy has not been done. An experienced surgeon
ome familiar with the route of the urethra and will draw the
t injury. When reintroduction is to be made after withdrawal
or other cause, a filiform bougie of double length or a blunt
introduced through the calibre into the bladder to serve as
ntroduction. In the majority of cases a finger introduced into
with thumb on the perineum, will locate the route of the cath-
withdrawn, and by remaining in position will accurately guide
strument into position. In an emergency a curved grooved
answer. When a silver catheter is used, the secret of success-
without injury lies in keeping the handle of the instrument
SELY IN THE MEDIAN LINE of the body, and the point along the
URETHRA until the bladder is reached. The handle should
ed from the abdomen until the finger in the perineum or rec-
es that the bulbous portion of the urethra has been reached,
should be quickly carried in the arc of a circle beneath the
ubes and, guided by the finger, passed into the bladder.
of long slow distention the bladder should not be entirely
ie author once encountered a case of "incontinence" that had
four months. The bladder contained 29 pints—464 ounces—
filled the entire abdomen.[1]

the Bladder.—When the catheter fails to relieve the distention,
may be tapped with a fine trocar or aspirator without touching
m by keeping close above the pubes and puncturing downward
d. The rectal route is not as safe.

sation of Urine.—Following a wound of the urethra the escape
the surrounding injured tissues is the signal for violent inflam-
ably sloughing, gangrene and sepsis if unrelieved.

of the aperture will determine the direction and the degree of
n, as the perineal fascias control its dissemination. The an-
thral perineal region is that portion in front of a line drawn
tuberosities of the ischia, and is covered first by the superficial
ia, which lies directly beneath the skin and is continuous with
al fascia of the neighboring parts. This is sometimes called
r of the superficial fascia; beneath it is the second or deep layer
surgically be well divided into two portions,—the middle
ia, which constitutes the covering of the ischiocavernosus or
s, the bulbocavernosus or accelerator urinæ and the trans-
i muscles. This fascia is attached to the rami of the pubes and
externally to the crura of the penis as far back as to the tuber-
posterior border curving down behind the transverse perineal
tached to the deep perineal fascia, or triangular ligament, thus
ing off the anterior from the posterior perineum. Anteriorly,
us with the dartos of the scrotum.

[1] Willard, Brit. Med. Jour., 1885, ii, 1104.

The TRIANGULAR LIGAMENT or deep PERINEAL FASCIA, it should be remembered, is in no sense a ligament, but a dense expansion of the fascia propria closing up the anterior portion of the inferior strait of the pelvis. It is firmly attached to the symphysis and subpubic ligaments and along the rami of the pubes and ischia above the crura penis. It supports the prostate gland and between its two layers—one of which arises from the anterior lip of the ramus, the other from the posterior—encloses the membranous portion of the urethra, Cowper's glands, the artery and nerve of the bulb, a venous plexus, the pudic nerve and vessels, and the compressor urethræ muscle. Its base becomes blended with the middle perineal fascia at the central tendinous point of the perineum (Fig. 132). The superior layer of the triangular ligament is derived from the obturator fascia. The fascial attachments will at once explain the fact that as long as they are

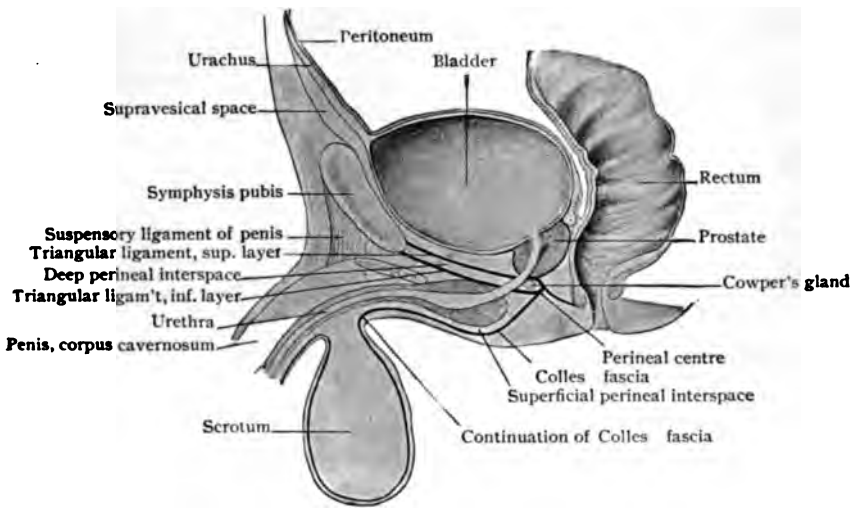

FIG. 132.—Diagrammatic sagittal section showing relations of fascial layers of perineum. (Piersol.)

intact, the urine, if escaping in front of the triangular ligament, is shut off from the posterior perineum and can only make its way forward to the scrotum beneath the dartos muscle, along the under surface of the penis and upward into the tissues covering the abdomen. It does not work down upon the inside of the thighs, nor backward toward the rectum, unless the prostatic region is injured.[1]

If rupture occurs in front of the posterior part of the bulb, the urine will be limited by the attachments of the deep layer of the superficial fascia. The urine cannot reach the ischiorectal fossa on account of the fascial attachment to the base of the triangular ligament; it cannot reach the thighs because this fascia is attached to the ischiopubic spine, consequently it must make its way into the scrotal connective tissue and above the pubes to the abdominal walls. Injury of the membranous portion carries the urine primarily between the layers of the triangular ligament where it is temporarily retained under tension until suppuration or sloughing occurs.

[1] Willard, Archives of Pediatrics, 1886, 65.

occurs in the prostatic portion behind the superior layer of the gament, the urine may work backward around the rectum or the thin pelvic fascia to the subperitoneal connective tissues. xtravasation is in front of the superficial perineal fascia, the ake its way in all directions. Pus infection speedily breaks fascial boundaries.

nt.—The perineal tissues, after a wound of the urethra, should y irrigated with hot carbolized solution, and wet boracic dress- or the patient may sit continuously in a hot bath. If signs of extravasation of urine appear, the perineal region must be pened by extensive incisions, stimulants given, and antistrep- n administered. If extravasation has occurred, the anatomical noted are important in determining the site of the rupture. perineal urethrotomy under ether should be at once performed, upon a staff in the urethra in the median line, searching for incising it cleanly and puncturing thoroughly all the surround- nat are infiltrated with urine, blood, and pus.[1] The catheter eeded, as the urine will escape by the wound. As the urethra nulation, steel sounds must be frequently introduced to mold new urethra. If the urethra has been entirely torn across, uld be sutured. The search for the posterior segment is facil- nering strictly to the median line and by using a straight sound irector through the perineal wound.

TED AND CONTUSED WOUNDS.—Lacerated and contused wounds y kicks, blows, or vicious handling of the parts. The frenal netimes torn in coitus. Extreme laceration—*fracture of the* ge boys may occur from sudden bending of the organ while If the skin remains intact, the extravasation of blood will be e organ is bent to one side the skin should be incised, hemor- d, and the firm fibrous capsule of the corpora cavernosa sutured ized gut to prevent subsequent deformity. It is difficult to gan so variable in size, but after thorough cleansing, aseptic t pieces of whalebone or match sticks may be bound in place e strips. Excessive edema in lacerated wounds may be re- ssure or by puncture and by aseptic dressings.

FORATE MEATUS; URETHRAL ATRESIA; CONGENITAL OCCLUSION.

rvious meatus or urethra is rare, but if present may lead to the a urethral fistula by bursting of the canal in intra-uterine life. y delay in the passage of urine by the infant, the surgeon should mine the penis, but should not be in haste to interfere as a few may result in voluntary expulsion of the colorless water, espe- nfant is placed in a warm boric acid bath.

ion is discovered at the meatus, the membrane may be punc- ong the canal, a small catheter or sound or a grooved director

[1] Willard, Archives Pediatrics, Feb., 1886, 68.

may be gently introduced. Complete closure of the anterior canal may require slitting of the tube and the plastic formation of a new urethra, or in narrowed strictures internal urethrotomy may be practised.

FOREIGN BODIES IN URETHRA AND BLADDER.

Vesical calculi may escape from the bladder and lodge in the prostatic or penile portion of the urethra. Boys and girls, especially after the time of puberty, frequently introduce foreign bodies into the urethra either for sexual excitation or to relieve strictural retention. The variety of these objects is great: pencils, beads, sticks, pins, glass rods, hairpins, and articles of unusual shape are often introduced by lecherous or drunken adolescents.[1] Old brittle catheters frequently break and a piece is carried by the reverse action of the compressor urethræ muscle backward into the bladder, or a too short catheter may escape from the grasp of the surgeon and quickly make its way into the viscus. If retained in either urethra or bladder, these objects induce an abscess or a calculus, especially as their presence is likely to be concealed until pain or other trouble compels confession. Even then the surgeon must be on his guard against deception. A sharp object may have its anterior point caught in a fold of membrane during an erection of the penis and upon each subsidence be driven further backward.

Symptoms.—The symptoms of urethral irritation, urinary obstruction, and periurethritis will call attention to the probable cause of trouble, in spite of negative or untruthful statements.

Diagnosis.—The history of the cause will often be deceptive, but an examination of the urethra and rectum or vagina by catheter or finger will usually disclose a hard object. The endoscope and the X-ray should also be utilized.

Treatment.—In the majority of instances the urethra will have been either lacerated or perforated by self-endeavors at extraction before the trouble is referred to the surgeon. The size, shape and character of the object should be ascertained and a duplicate obtained if possible.

If the object is still in the urethra, the first effort at extraction should be made by closing the meatus and distending the urethra with urine from the bladder. Should this fail to dislodge the object, the canal may be filled with sterile oil. Cocaine or ether is advisable.

Evacuator.—Before using forceps, a Bigelow evacuating tube with open end[2] (Fig. 136) and of diameter as large as can be admitted into the nicked meatus should be carried in and an attempt made to engage the object in its mouth by elongating the urethra and by loosening the anterior point of the foreign body. By compressing the urethra behind the object and dilating the canal slowly with warm water and then making sudden suction with the evacuating bulb, small objects, as beads, sticks, pebbles, can be successfully withdrawn. In the absence of a Bigelow (Fig. 133), Otis or other evacuator, a suction syringe may be used. If the object is a pin or sharp-pointed instrument, it can thus be withdrawn without injury to

[1] Poulet, Foreign Bodies, ii, 97, 113, 209.

[2] Willard, Foreign Bodies in Urethra and Bladder, Trans. Phil. County Med. Soc., 1887, 215; Archives Pediatrics, Apr., 1886; Phila. Medical News, Nov. 26, 1887.

the urethra, or the point may be imbedded in a wax bougie. Bonnet pins that cannot be caught may be brought out through the wall of the urethra, withdrawn as far as the head will permit, then reversed and pushed out of the meatus.

FIG. 133.—Bigelow's aspirator and evacuating tubes. An extra tube with open end for removing foreign bodies from the bladder is seen in Fig. 136 *A* and *B* (next page). (Wharton and Curtis.)

The two points of a hairpin in either male or female urethra can be pressed together and inserted in an evacuating tube and gradually worked out without laceration of the canal. In the male, one limb of the hairpin may be pushed through the urethral wall, after which by reversion the other arm may be withdrawn. The author safely extracted a large sail-needle—6 inches long—(which had been twice pushed through the walls of the urethra in efforts at self-extraction) by elongating the urethra, disengaging the end and enclosing it in a canula.

FIG. 134.—Foreign body grasped in urethra (Agnew).

FORCEPS. — Forceps manipulation must be exercised with caution, as any rough object withdrawn through the urethra will seriously wound the walls; for this reason the suction tube is safer. If the object is small, slender forceps may be manipulated through the tube (Fig. 134). If lodged in the fossa navicularis, a scoop may dislodge it or the alligator forceps may be used (Fig. 135).

INCISION OF THE URETHRA.—If the object is rough and imbedded in the walls, incision is safer than forcible extraction through the canal. A clean, aseptic cut at any point in the penis or scrotum with extraction and immediate suture is a simple operation. Perineal section or external urethrotomy may be required if the object is lost in the bulbous or prostatic urethra.

The object not infrequently passes from the urethra into the bladder. It may be located by steel sound, by the endoscope (Fig. 140), or the X-ray if metallic, or by a small lithotrite. The straight Bigelow litholapaxy evacuator tube with open end (Fig. 136) becomes the most valuable extractor of short fragments of old catheters, beads and small objects of the diameter of the tube. A duplicate object, if obtainable, should be tested as to

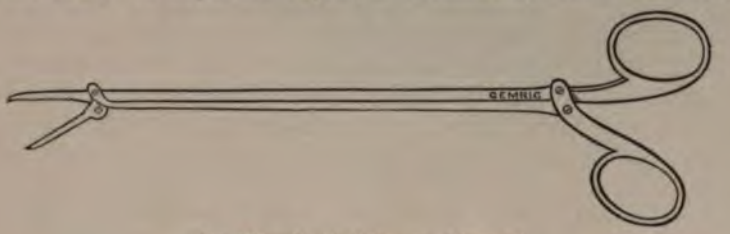

FIG. 135.—Urethral forceps. (Agnew.)

its admissibility into the canula. The bladder should be slowly distended, then suddenly evacuated, and the process repeated a number of times. If the rubber catheter or pencil or stick is too long to enter the tube, it may be crushed with a small fenestrated lithotrite and the evacuator again employed. Small round objects may be sucked through the ordinary curved tube with side opening. Prostatic stones can be loosened and secured by this plan. Through this tube as a protection to the urethra, forceps may be

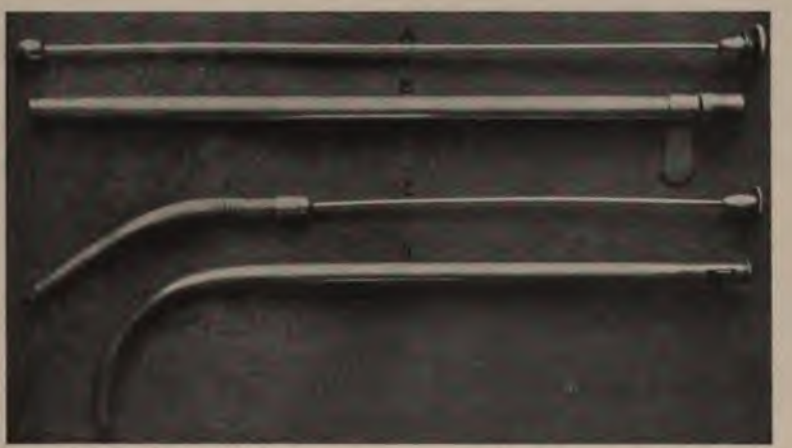

FIG. 136.—*A*, obturator for tube; *B*, Bigelow evacuating tube with open end for removing foreign bodies and blood from the bladder; *C*, spirally cut obturator, which acts as a suction piston; *D*, author's catheter with large eye closed by obturator to prevent blocking with blood during introduction.

passed and the object grasped and extracted within the tube. Great care must be exercised not to lacerate the urethra. By one of these methods a broken lithotrite jaw may sometimes be secured without a cutting operation. Divulsors, basculeurs and duplicators are now seldom used.

BLADDER INCISION.—For large and irregular shaped objects within the bladder a median perineal or suprapubic opening should be made, as for the removal of a vesical calculus (p. 211).

t urethra in girls permits easier and safer manipulation. It
nembered that a missing object may be found in the vagina[1]
the urethra or bladder. In large girls instruments introduced
se of producing abortion are sometimes accidentally passed
ra or bladder.

the Bladder.—The best catheter for withdrawing blood-clots
der, or for general catheterization when any difficulty is ex-
e one shown in Fig. 136 *D*. In difficult catheterization an ordi-
nt is often withdrawn with the eye filled with a clot, and the
t be certain whether there is urine in the bladder or not. This
e author is made in various sizes and is of immense advantage
in bleeding cases. The silver tube is provided with a spirally
turator that effectually closes the long three-quarter inch eye
der is reached, when it is suddenly withdrawn, thus acting as
n, and the surgeon knows that the opening cannot be blocked
f any subsequent obstruction occurs, the obturator can be
without injury, rotated, and the eye cleared. The clots in
may then be sucked out by the litholapaxy evacuator (Fig.

ADHERENT PREPUCE; PHIMOSIS.

Elongated and contracted foreskin; atresia or stenosis of prepuce.

ent prepuce is the normal condition at birth, being simply a
f the intra-uterine condition of the cells of the rete Malpighii
ed to harden upon the under surface of the fold. These cells,
toplasmic, agglutinate the two surfaces so slightly that dur-
ew weeks of life they are easily separated by gentle traction.
the adhesion becomes more firm and the condition of CON-
UCE OR PHIMOSIS follows. Elongation is usually a later result.
IMOSIS exists when the adhesions have not been loosened
en the mucous surface of the prepuce is so condensed and
the glans cannot be exposed. If the glans has not been un-
e age of ten, and in cases with balanitis, removal sometimes
ssary. Atresia preputii tends to retard the growth of the glans
e smegma.

D phimosis in larger boys is due to balanitis or other inflam-
les, especially gonorrhea.

e boy attends school he will not be long in discovering that it
ble condition not to be able to uncover the glans, and he will
rsistently become his own surgeon and will free the adhesions.
n is also hastened by the common practice of distending the
rine. The object of the prepuce is two-fold: to protect the
during the early years of life, and later in coition, to enhance
the ejaculatory orgasm by its friction over the corona. The
ndition of childhood is a FREELY MOVABLE PREPUCE OVER A
s, and as such a prepuce is readily cleansed it is equally health-

[1] Poulet, Foreign Bodies, ii, 187.
[2] Willard, Catheter for Blood, Phil. Med. Times, xvi, 853.

ful in adult life. It has been shown that friction of clothing upon the exposed glans in Hebrew children causes a plastic hardening of the membrane, and that reflex disturbances are equally common in that race.

Reflex Phenomena.—The reflex phenomena that have been attributed to genital irritation are numerous; many of them are real, others fanciful. Reflex paralysis from peripheral irritation is not uncommon in any part of the body, and the genital system is so complex in character and so varied in its psychical manifestations that the presence of hardened smegma or contractile pressure on a glans may readily induce incoördinate and uncertain muscular contractions and many nervous phenomena. A few of the more common accompaniments that may be caused or exaggerated by, or be coexistent with, contracted prepuce are incoördinate muscular action, chorea, nocturnal incontinence, malassimilation, dysuria, frequent micturition, priapism, night terrors, convulsions, epilepsy, mental defects, hernia, prolapsus ani, hemorrhoids, etc.

Malnutrition consequent upon or coincident with contracted prepuce may be in a few cases responsible for non-resistance to the tuberculous bacilli in spinal caries and hip disease, but the author has seen many children who have been unwisely promised relief by circumcision, even when their condition has been due to a true spinal caries or hip disease, yet incorrectly diagnosed as "reflex irritation."

In the experience of the author, the exposure of the unprotected glans penis to friction of clothing during childhood is a cause of nervous irritation. If the prepuce is stripped from the glans in infancy, so that the neck behind the corona can be readily reached and cleansed, no irritation will occur.

Reflex phenomena and incoördinate movements in girls should lead to a careful examination of the genitals, to thorough daily cleansing, to correction of vaginal discharge, to stripping of the hood from the clitoris if adherent, and to freeing of adherent labia. Even the slight irritation of adhesions may call the attention of the girl to these organs and induce masturbation (see p. 202). A variety of reflex nerve symptoms have been observed in girls as well as in boys.

While an accumulation of smegma and an actually contracted prepuce undoubtedly has some effect in the production of these symptoms, yet it is only one element in a variety of causes. A long prepuce is not necessarily an adherent one. The uncovered glans is no more easily cleansed after a foul coitus than one with a freely movable prepuce. Cleanliness is the secret of health in this organ as in other parts of the body. Circumcision by the Hebrews was primarily a religious rather than a sanitary rite and was readily adopted by the heathen nations, as it was the only external evidence of a difference between peoples, and by this means other nations undoubtedly hoped to obtain Divine favor.

In exceptional cases only will circumcision be necessary. Symptoms referred to adherent prepuce may be due to vesical calculus or renal or bladder disease. When there is stenosis which has continued to adolescence or adult life, circumcision is of course advisable, although in one case a patient of the author had mania following this operation. Night terrors and night cries should always induce the surgeon to look for joint disease or other cause. While choreic or incoördinate muscular move-

e present in a case of adherent prepuce, other causes should ught; a deeper and more central disease will usually be dis- cases of defective cerebral development and cerebral and ments, prognosis should be guarded and an operation should rtaken as one of the means of relieving a possible cause of ent.

NT MUSCULAR COÖRDINATION OF CENTRAL ORIGIN as witnessed cannot be cured by circumcision, yet it is not unwise in such ve even one of several probable causes of reflex irritation, as s lack self-control and are liable to become masturbators. In ion is preferable. Too frequently a serious spinal or brain elessly overlooked, simply because the boy like hundreds of as a slightly adherent prepuce.

t.—STRIPPING THE GLANS.—This simple operation requires ts if performed in the first month of life. Later, slight stretch- eps may be required. Many apparently contracted prepuces erent and by gentle retraction an almost pinhole opening will and disclose the meatus surrounded at a little distance by a esion uniting the prepuce to the glans. Continued traction thumbs and fingers will readily strip these adhesions, and orona will be found hard masses of smegma, the presence bably accounts for the reflex nervous symptoms sometimes Occasionally a probe will be needed to separate the ad- smegma should be cleared by probe and the sulcus behind lly exposed, washed, and surrounded with a bit of cotton cov- rolatum or oil. The prepuce must be restored to its normal NCE or paraphymosis from swelling will occur. If difficulty lacement, a couple of probes or hairpins inserted beneath the will assist in reduction (p. 202). The oil and cotton dressing epared in advance so that no delay will arise to produce a s. The cavity may be injected with oil daily until tenderness ed, after which the penis should be washed and oiled frequently adhesion. This region needs cleanliness daily as much as do d face, lest balanitis result. If regularly done, it excites no n than the handling in urination. There are but few cases in which stripping cannot be done, especially if a probe is swept ircumference of the glans. A novice will be surprised to see n apparently contracted prepuce will slide over the corona. born cases, DILATATION with forceps, or even SLITTING of the ng under cocaine, may become necessary. If the family phy- us strip the prepuce during the first few weeks of the boy's difficulty will be experienced in freeing it and contraction ion will be avoided.

ISION.—With an elastic band encircling the penis, sequestra- a by cocaine is readily accomplished and only a small amount ermic is required (Fig. 137). In young children, ether is ad-

Adherent and Contracted Prepuce, Phil. Med. Times, June 30, 1883; Keat- Chil., iii, 638; Archives Pediatrics, iii. 385 and 669, 1886; Phil. Med. and 1885; Trans. 9th Med. Cong., Wash., 1887, iii, 473.

visable. In masturbating boys, the moral effect of the operation will be increased if no anesthetic is employed. The usual error in circumcision and the failure to secure a neat looking organ results from removing too much skin and too little of the mucous face of the prepuce, since the imprisonment of the glans is always due to the latter fold. A small amount of skin only should be sliced, the mucous face slit along the dorsum, not torn, then the mucous layer is cut away until the corona is fully exposed, but a narrow circumferential strip is left sufficient for suturing with catgut to the opposite raw edge of skin (Fig. 138). These interrupted catgut stitches will not require removal. The unpleasant and distasteful folds of skin often left beneath the penis at the frenum should be avoided by proper trimming at the time of operation. To simply slit a prepuce along its dorsum and allow two loose baggy folds of skin to hang below will not be viewed with pleasure by the boy in later years. The organ should be made as comely as possible. The retained surplus skin will later form a sufficient covering fold for the glans and readhesion will not occur. A slender encircling strip of cotton smeared with petrolatum is the most comfortable dressing. A nest of aseptic gauze should then be packed about the penis, retained by diaper and renewed at each urination. When no anesthetic is used, sutures may be avoided by wrapping the penis behind the corona with a strip of dry gauze.[1]

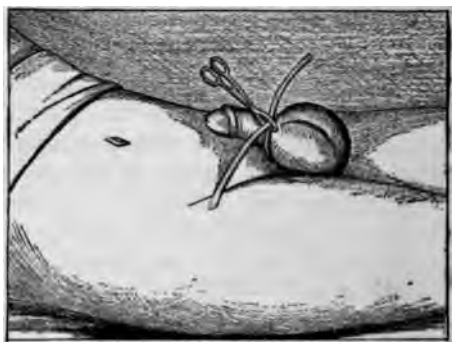

FIG. 137.—Sequestration anesthesia with cocaine and elastic band (Ely).

FIG. 138.—Circumcised penis, with thickened mucous surface of prepuce removed and edge sutured to the retracted skin. Only a small amount of skin has been removed, it having been left redundant in order to form a protection for the uncovered glans.

A great variety of forceps have been devised for circumcision. These instruments are entirely unnecessary as the induration is usually from thickening of the under surface of the prepuce, not from the skin. Any operation that fails to remove this thick fold is imperfect in its result. It is therefore wiser to administer an anesthetic rather than to inflict unnecessary pain. Even if cocaine is injected and the penis encircled with an elastic band the sight of instruments and manipulations will frighten a young child.

SUMMARY.

1. Adhesions of the prepuce to the glans are almost universal at birth, but they can easily be separated during the first month of life.

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[1] Wilson, Archives Pediatrics, 1908.

st healthful penis is one with prepuce moving freely over a

herent prepuce can nearly always be relieved by simple nfancy. Stripping will avoid circumcision. Dilatation or ly necessary.
cision should be practised in contracted prepuce or true when simple measures fail and when reflex phenomena ap- om genital irritation.
ex, nervous, choreic, and paretic conditions, other causes irritation should always be considered.

PARAPHIMOSIS.

infrequently withdraw a narrowed prepuce behind the glans unable to replace it in its normal position. Retained, the on causes swelling of glans, edema of the foreskin, and may unrelieved, in sloughing. Delay of the surgeon in drawing repuce after stripping of the glans may produce this condi- wed prepuce may also be forced behind the glans in coition. —Firm compression of the glans for a few moments will ze, when by grasping the prepuce with thumb and fingers on efforts of the boy in his attempts to withdraw will elongate lessen its diameter sufficiently to accomplish reduction. An- is to compress the glans in the hand and slowly carry the pre- The glans can be readily reduced in size by wrapping it with er tissue or gum band. This constriction method is also of ad- a boy has slipped a brass ring over his penis and the ring has ded in the tissue. If the edema and constriction are great, it ary to etherize the patient and puncture the tissues, or to in- inted bistoury flatwise beneath the constriction and divide it.[1]

of the Penis.—Superficial sphacelus of the organ may be the pernicious habit of placing rings or cords around the neglected paraphymosis. A contracted prepuce forced be- a in a violent coition if neglected may also produce a slough. annot be reduced by hand pressure or by elastic tape after hat the prepuce can be brought forward, a bistoury must be e beneath the constriction. A metal ring may be divided one forceps or fine chain saw. The penis must be dressed s asepsis.

MASTURBATION.

ful effects of masturbation either in boys or girls are largely ct that it is a vice practised in secret, and consequently is by the lack of self-control in the individual. Even infant of neurotic type may accidentally discover that by crossing the genitals and making friction, pleasurable sensations are The author recently discovered an infant girl of twenty-one y crossing her thighs would exhibit signs of excitement for a

[1] Willard, Keating's Cyclop. Dis. Chil., iii, 647.

half hour at a time. If frequently repeated, these acts may be followed by nervous conditions, spasmodic muscular movements and even convulsions. If frequent firm erections occur, the cause of trouble may be discovered by the mother. Boys of even three years of age are not infrequently purposely sexually excited by vicious nurses. Older boys acquire the habit from companions. A lad may be brought to the physician for nervous symptoms varying from irritability to chorea, with loss of strength and of mental vigor owing to the strain upon his nerve centres, even before semen is secreted. If the penis is found reddened, somewhat edematous, and larger and more readily excited than normal, the suspicion of the surgeon should be aroused as to the cause of the weakness. In masturbating girls, the hood of the clitoris and the upper labia will be found reddened and edematous.

Exciting Causes.—ADHERENT PREPUCE, BALANITIS, RECTAL WORMS, CONSTIPATION and VESICAL CALCULUS may all act as causes, but the bad example of older boys is usually at fault, together with the reading of vicious literature. In institutions it is a habit exceedingly difficult to control.

Treatment.—The first step is to remove the cause which must be early and persistently sought. In all cases every source of genital irritation should be removed. An adherent prepuce must be stripped or circumcised, the operation being done without an anesthetic, to increase its moral effect. Stone in the bladder and other ailments must be appropriately treated. In infants, close watching will be required. In young boys, a small area of the prepuce may be occasionally vesicated with iodine or cantharidal collodion to keep the organ slightly sore. In boys or girls old enough to reason, the disadvantages and physical and moral results must be placed calmly, judiciously, and earnestly before them and their self-respect aroused. By self-control only can the habit be permanently broken. In girls, the hood of the clitoris should be stripped and thorough cleanliness insisted upon, with attention to leucorrheal irritating discharges (p. 172). Pruritus in either sex should receive prompt treatment (p. 170).

In adapting an extension hip splint or any apparatus requiring perineal straps, surgeons should exercise care that the pelvic steel band should be long enough to carry the strap well out in the groin. If the strap falls into the vulvar cleft and across the clitoris, its friction may readily develop evil habits.

BALANOPOSTHITIS.

Inflammation of the glans and of the prepuce is usually dependent in young children upon uncleanliness, especially when the prepuce is tight or adherent and if smegma accumulates beneath it. In older children it may be caused by masturbation, gonorrhea, or trauma. It is evidenced by redness, a slight purulent discharge, itching, and edema.

Treatment.—Cleanliness is of prime importance. Boric acid solution or oil may be injected beneath the prepuce, but speedier subsidence will be secured by at once freeing an adherent prepuce by stripping or removing a contracted phimosis by circumcision, after which thorough cleanliness and dry or oil dressings will give speedy relief. Zinc stearate or bismuth powder is excellent.

A diphtheritic balanoposthitis should be treated locally with silver nitrate solution while antitoxin is administered.

SPERMATORRHEA.

past puberty, involuntary discharges of semen are not uncom-
those who have not practised masturbation. Imposters and
octors so often prey upon these boys, first by supplying them
literature, and later with terrifying reports of the dangers that
he practice of self-abuse, that the victims fall readily into their
boys will come in alarm to the surgeon complaining that in
or during a dream in the night, an emission has taken place.
the part of the surgeon wisely and plainly to counsel the boy,
that with abstinence from masturbation and from vicious
companions an emission even once a week will not injure
nission is simply an overflow, and an erection in the morning
arge boy with full bladder is practically normal. The emission
nted by promptly getting out of bed and passing his water.
rain from manipulation of the penis and keep his mind and
the impulse, which is but a natural one, can be controlled by
The worst advice that can be given him is that he should
habitation. The most experienced physicians will testify that
roubles like varicocele are in no wise caused by continence.
ble-minded boy may become a spermatophobic, thousands are
norrhea and syphilis, their lives rendered wretched, their wives
destroyed by disease, and for these deaths they will be respon-
xual instinct is of course an imperative one in every boy, but
can and must be controlled if health of mind and body is to
d. The sexual appetite is one that will be increased, not satis-
asional indulgence, and absolute continence is far easier than
int. Perfect health is fostered, not injured, by continence.

nt.—The first element in treatment is psychological, followed
ics, nux vomica, iron, etc. Eating or drinking of stimulating
r should be avoided, especially at night. Next should be the
very exciting physical cause. Adherent prepuce, genital irri-
kind, pruritus, calculus, etc., should receive proper treatment.
important is an abundance of vigorous exercise in the open
horseback riding is provocative of friction. Cold bathing, a
ard bed and light covering are advantageous. Whenever
an erection, the boy should quickly rise from bed, pass his
orously swing a pair of dumb-bells or clubs for a few minutes.
can thus be practically avoided. Mentally and morally, the
e strengthened by the avoidance of lewd thoughts, obscene
conversation, vicious companions, male and female, and by
n of honor, self-respect, self-control, and true Christian virtue.
emissions occurring without erections in nervous patients
masturbation or by venery will require a change of occupa-
ve, healthful, vigorous out-door life, nerve tonics and diges-
rough regulation of all habits calculated to strengthen feeble
odies. The passage of a large steel sound into the urethra
will relieve undue sensibility. When a prostatic secretion
spermatozoids (which secretion is often mistaken for semen)

is exuded during straining at stool, a ten-grain solution of silver nitrate or argyrol, carried on a sheathed applicator to the orifices of the ejaculatory ducts, is helpful.

SPERMATOPHOBIA.

As the marriageable age approaches, many young men will become greatly excited by quack literature concerning the danger of incompetency, and will avoid marriage and render themselves miserable simply because they are subject to occasional emissions. If they refrain from any friction of the penis by the hand, an emission once in a week or ten days will be simply an overflow and need give no concern. Under the normal environments of matrimony, and with regulated self-control, all such fears speedily disappear, and happy fatherhood results. Functional impotency (impotentia coeundi) is usually temporary and largely mental. An individual disturbed by these fears should be assured that if masturbation, cohabitation, the reading of lewd and of quack literature, lascivious companions and thoughts are avoided, no trouble need be anticipated. No worse advice can be given than that of experimental cohabitation. If unsuccessful, as would be probable under mental perturbation, the disturbance of mind will be seriously increased. After marriage, the ignorance of the wife will cause any temporary failure to be unnoticed. The sexual appetite is one that can only be regulated by rigid self-control. No youth was ever yet seriously injured by continence, while thousands are yearly infected, and many thousands of wives and children are murdered by venereal disease in the husband and father (p. 316). Pathological impotency (impotentia generandi) is rare except from gonorrheal epididymitis. For true sexual neurasthenia or sexual torpor, iron, nux vomica, phosphorus, damiana, and exercise are beneficial.

ENURESIS—INCONTINENCE OF URINE—BED WETTING.

A continuance of the infantile habit of urinary discharge is due to maleducation or to some physical defect. If no malformation exists, the mother should see that the child is properly trained early. This condition lasting until puberty is due to some special cause. A contracted prepuce, balanitis, narrow meatus, stone in the bladder, cystitis, rectal worms, fissure, polypi, and urethral caruncle, leucorrhea, vaginitis, and adherent clitoris or labia are not uncommon causes.

The distribution of the genito-urinary branches of the sacral plexus of nerves is sufficient to account for the reflex influences transmitted through the spinal cord from penis or vulva to bladder. During sleep when voluntary control is lessened, relaxation of sphincter and muscular action of bladder walls is sufficient to cause an outflow.

Treatment.—In each persistent case of nocturnal incontinence, or of diurnal escape under nervous excitement, a thorough investigation should be made and proper treatment instituted. Chorea, nerve and muscular weakness, anemia, profuse or concentrated urine and bad habits should all receive attention. Removal of the cause should precede medical treatment. Every persistent case should be repeatedly sounded for stone in the bladder.

of the steel sound occasionally repeated is of advantage in re-
bility of the urethra.

L TREATMENT.—Belladonna is the remedy upon which most
been placed. It must usually be given until decided constitu-
appear, and continued for a long period of time. Large doses
es tolerated before there are any toxic symptoms save dila-
e pupils. Belladonna given in sufficient quantities to dilate
roughout the night is helpful. From $\frac{1}{1000}$ to $\frac{1}{50}$ of a grain
egulated by the age, should be given every hour in the late
til the pupils dilate. The dose may be repeated during the
pupils contract. A convenient solution of atropia for use is
the ounce of distilled water; one or two drops then being the
year of age;[1] $\frac{1}{640}$ of a grain of atropia may be considered
bout ten drops of officinal tincture belladonna. Suppositories
a, nux vomica and ergot may be given at night.

L TREATMENT.—A prepuce should be made freely movable
al glans or should be removed,[2] a contracted meatus slit, a
oved, clitoris and labia released, and all exciting causes in
worms or constipation, relieved. A boy is often punished for
when it is impossible for him to avoid the sudden expulsion
ng to stone in the bladder. Food should be nutritious and
ng. Condiments and sweets should be avoided and but little
taken in the after part of the day. A regular out-door life
intained, and after the cause has been removed the bladder
wly educated to retain the urine a little longer each day. Ex-
d or alkaline urine must be corrected and the pride of the
ed, rewards being usually better than punishment. The com-
e above puberty unless some actual lesion exists. The child
e permitted to remain too long in bed without rising to
eping upon the back with consequent pressure of urine upon
trigone of the bladder may be prevented by fastening a hard
e the sacrum and by elevating the hips. The muscular and
ust be increased by nux vomica, strychnia, iron, etc.

tent cases in girls, Gersuny advises dissecting back the entire
e of the urethra, rotating it three-quarters on its longitu-
d stitching with chromicized gut,[3] but such an operation is

SICAL CALCULUS; STONE IN THE BLADDER.

calculus is very common and nearly one-half of the cases of
nd in children, even in infants at birth. The deposit may con-
, phosphates, oxalates, or cystine, in the form of a concretion
by particles or around a foreign body. The shorter and larger
rls permits the easier escape of nephritic calculi, so that the
thrice as common in boys as in girls. Stone in the bladder is

[1] Owen, Surg. Dis. of Children, 1897.
[2] Willard, Archives Pediatrics, 1886, 65.
[3] Annals of Surgery, Nov., 1908, xlviii, 792.

much more common in India, China, and Egypt than in the United States, due probably to food and water causing incomplete metabolism. Although uncommon in the colored race it has been seen by the author.[1]

Symptoms.—The first symptom of a forming concretion is an irritability of the bladder—a weakness—which is evidenced by frequency of micturition, night and day. As the stone increases in size, pain becomes positive both at the neck of the bladder and at the end of the penis or in the vagina or rectum, owing to the disturbance of the sacral plexus of nerves. An infant screams at each passage of water, the stone blocking the internal orifice of the urethra causing sudden arrest of the flow of urine; a larger boy strains until he produces prolapse of the rectum and hemorrhoids.

The imperative contractions of the bladder walls produce uncontrollable evacuations of urine and he is often punished for incontinence. As cystitis advances, blood, mucus and pus appear. The boy obtains relief by passing his urine in the knee-shoulder position, thus throwing the stone to the top of the bladder. The irritation and pain in the perineum and at the end of the penis cause him to pull at the prepuce, elongating it and rendering it edematous, subjecting him to the accusation of masturbation, especially as priapism from congestion of the vesical neck is frequent. It is strange that a physician, knowing these symptoms, will permit them to continue for so long a time but the author has known a stone to be carried in the bladder for twenty-seven years before operative relief was sought.

Every boy or girl presenting the symptoms of irritable bladder, frequent and painful micturition, incontinence, hematuria, hemorrhoids, or prolapse should be carefully examined with searcher or with steel sound, not only once but many times if the symptoms continue. A boy presenting the symptoms of stone should not be dismissed simply with the correction of an adherent prepuce, since nearly every young boy has an adherent prepuce if the glans has not been uncovered in infancy when stripping is so easily accomplished. If symptoms persist, a CYSTOSCOPIC examination by an expert should be employed.[2] In using a cystoscope, the liquid in the bladder must be washed clear of blood, pus and mucus. The X-ray is occasionally of advantage, but the bladder is deep in the pelvis. The sounding must be done under thorough asepsis of instruments, surgeon's hands and of glans penis.

Nitrous oxide, ethyl chloride or chloroform should be administered. The sound should be of size to easily pass the meatus and should have only a short beak. In larger boys, cocaine may be used in urethra and bladder, but with caution. The bladder should at first be moderately distended with urine or boric solution which should be allowed gradually to escape.

A finger in the rectum will assist in lifting the stone in either boy or girl (Fig. 139). Alternate elevations of shoulders and of hips may bring a stone into line of touch. A single examination should not be conclusive in the presence of continued symptoms, as the most experienced diagnosticians have been deceived. The author recalls finally discovering by lithotomy a stone that had evaded examinations by numerous surgeons. It was found attached upon the tip of a small elevation of mucous mem-

[1] Willard, Archives Pediatrics, Jan. 1, 1892, and 1886, 520.
[2] Nitze, Atlas der Kystoscopie.

brane. Another calculus was found covered with pus and half imbedded in inflammatory exudate, like a stone in the mud. The click of a stone is recognizable both by the touch and by the ear. In doubtful cases, a lithophone or sounding board will magnify the vibrations. A telephonic sounding board is helpful. Calcareous concretions on the bladder wall will give a roughened surface. If a stone is detected, a small well-anointed LITHOTRITE should be introduced and the dimensions of the calculus measured.

Treatment.—There is but one treatment for stone in the bladder, that is, removal. Potassium citrate, salol, lithia, piperazin, urotropin, benzoates, sandalwood, or belladonna may be given temporarily to mitigate symptoms and render the urine bland.

LITHOTRITY.—The crushing of a stone in the bladder and permitting the fragments to be extruded by the voluntary efforts of the patient has been superseded by litholapaxy.

FIG. 139.—A finger in the rectum is of assistance in raising a stone so that it can be reached by the searcher. (Agnew.)

Litholapaxy.—The crushing of the calculus and the IMMEDIATE removal of the fine detritus through the evacuating apparatus of Bigelow at a single operation marked a most important advance in the treatment of stone. The employment of reliable small lithotrites and the fact that the urethra of boys bears dilatation well has caused this method, at the present time, to be looked upon with favor by the majority of surgeons. If the bladder and urethra are fairly healthy in boys over two years of age and when the stone is not too large or hard, it becomes the operation of choice. The meatus may be nicked (*meatotomy*), the urethra dilated in advance and sizes 4 to 10 used.

An instrument combining cystoscopy with rongeur forceps and cautery is most convenient, as the stone can be both seen and extracted (Fig. 140).

The requisites for successful litholapaxy are an ABSOLUTELY RELIABLE make of LITHOTRITE, Forbes' pattern (Fig. 141), the minute crushing of the stone, the complete evacuation of every fragment (even if an hour is consumed), and most of all, a careful surgeon with touch trained to recognize the freedom of the bladder wall from the grasp of the instrument during the seizing and crushing of fragments. The child should be anesthetized by an experienced assistant, the instruments sterilized and thoroughly anointed with borated lanolin, the bladder only moderately filled with boracic solution with a very slight admixture of cocaine, adrenalin and morphia. Should the lithotrite become clogged or broken, it should not be withdrawn to lacerate the urethra but a suprapubic operation should be performed at once. A cheap make of lithotrite is most expensive.

The comminution should be made as complete as possible at the first introduction to avoid repetition. A Bigelow evacuator (Fig 133, p. 196) or the combined crusher and evacuator of Chismore may be used.

The grasping of the stone may be facilitated by elevating the hips. The closed instrument should first discover the calculus, then, with female blade fixed, the male blade is opened to the estimated width of the stone, the concretion grasped, slowly fixed in the bite of the instrument and the beak then gently turned from side to side to be certain that bladder wall has not been included. Haste and ill-judged force are the great dangers in the operation. Repeated gentle maneuvers may be necessary to secure the stone. When grasped, if of moderate size, it is then crushed, frag-

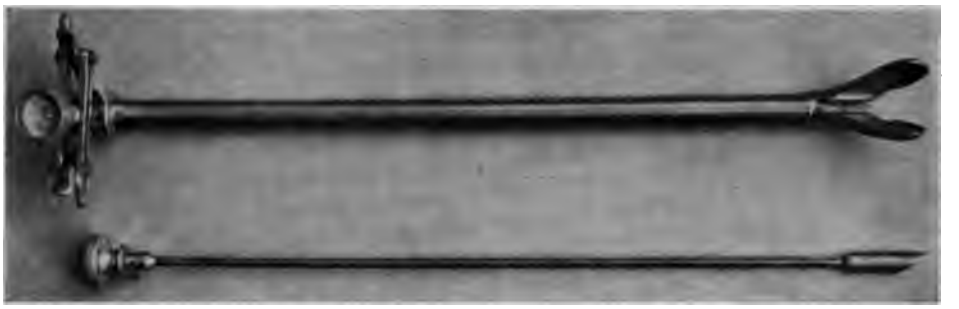

FIG. 140.—Cystoscopic rongeur. A calculus can be simultaneously seen and grasped (H. H. Young).

ment after fragment being seized in turn and comminuted fine enough to pass through the evacuating tube. The crushing process should be done in the centre of the bladder, and in grasping the fragments, the male blade should press as little as possible upon the sensitive neck. A pinion crusher or an automatic hammer is seldom needed in children.

The evacuator of Bigelow (Fig. 133) is the type, but the instruments of Chismore, Otis, and others are serviceable and cheaper. The boric solution in the evacuator must not be driven too forcibly into the bladder or the mucous membrane will be wounded with the fragments, or rupture of the viscus be produced. The introduction of air into the bladder

FIG. 141.—Lithotrite in sizes 4 to 10 for children.

can be prevented by filling the tube with water before introduction or by filling it from the bulb while in the lower portion of the urethra. If air enters the bladder, it may be sucked out from the highest point of the viscus. The evacuation of fragments is continued until detritus no longer appears in the receiver.

If fragments still click against the eye of the instrument, further crushing by the lithotrite is necessary. Before withdrawing the evacuator any fragment caught in the orifice should be forced out either by the liquid or by an obturator. An open-end or a side-opening tube may be used. The flap of the bladder wall against the open end is readily discernible. If all fragments can be removed in an hour it is better to secure the last piece

though an exploration two weeks later should never be neg-
me portion has been overlooked.

REATMENT. — Litholapaxy is a major operation, especially
anied, as is necessarily the case, with more or less cystitis,
kidney infection. Urethra and bladder have been subjected
and circumstances must be extreme that should permit the
exposed to cold or wet or exercise. There is no sufferer from
or adult, that cannot afford to give the same period of thor-
t is essential to safety in any operation of this magnitude.
days in a warm bed will abundantly repay any patient. Sup-
pium should be introduced as needed and urotropin given.
and septic urethral fever are not uncommon even after skil-
ic operations.

ns.—In introducing a lithotrite, no force is to be used, the
ing allowed to slowly glide in by its own weight. Before the
perfect working both of lithotrite and of evacuator should
2 per cent. solution of cocaine with adrenalin can be safely
o the bladder in large boys and girls. The density of a stone
mucus is deceptive. During the crushings, the blades must
. The various manipulations of the beak required in searching
ng fragments depend for their safety upon the delicate tactile
the surgeon. If the bladder is accidentally ruptured during
eliotomy should be at once performed and the bladder sutured.[1]
ce is in larger proportion than after suprapubic lithotomy,
are left behind in one-fifth of the cases, owing to the difficulty
e-examinations in children. Recurrence from fresh kidney
the same in litholapaxy and in lithotomy.

xy in Girls.—The shorter and larger urethra in girls not only
oluntary passage of stones, but ensures easier manipulations
alculi that have been arrested. A LITHOCLAST is sometimes
ent than a lithotrite. A finger in the rectum or vagina will
seizure. A straight open-end evacuator can be used, other-
ation of litholapaxy is similar to the procedure in the male.
rethra can be dilated with finger or forceps. A vaginal or
hotomy is rarely necessary. The author once operated on
vesicovaginal fistula produced by the laceration of a cal-
against the pubic arch in advance of a descending head in

MY.—For unusually large concretions, or in very hard oxalate
s, incision of the bladder may become necessary. It is also
that is best suited to infants under two years. As to the
ning the bladder, surgeons will differ according to their ex-
particular method.

ubic Lithotomy. — The suprapubic route in now pre-
United States and has largely superseded the lateral perineal
possesses the advantage of fewer dangers if the fold of peri-
oided, as the anatomical surroundings are simpler than those
m. It permits a freer examination of the interior of the viscus,

[1] Ann. d. Mal. d. Org. Genito-urin., Paris, 1908, ii, 1459.

the discovery of ureteral or of multiple or of unusually placed stones, and avoids injury of the seminal ducts, which latter is a very important consideration. Per contra, the peritoneal cavity may be opened and in careless or inexperienced hands the bladder or the rectum may be ruptured by too large injections or by too free inflation of a rectal uplifting bag.

The bladder should be washed with boric solution, then moderately distended to raise the anterior peritoneal pouch, the catheter withdrawn, and a bandage tied around the penis. A surgeon without large experience can leave the catheter *in situ*, and, later, utilize the tip to lift the bladder wall to his pubic incision. If a rubber bag is inserted in the rectum to lift the bladder, care must be taken not to rupture the bowel. In fat children, the linea alba is not distinct, but the suprapubic notch will lead to the pyramidal muscles which lie directly beneath the sheath of the rectus. Separating these, the fat in the prevesical space of Retzius is nicked rather than torn. As soon as the pink wall of the bladder is exposed, it is caught on either side with curved needles and two silk traction sutures inserted. A quick puncture with sharp-pointed bistoury will release the contents but care must be taken that a small stone does not escape unnoticed. The wound is then enlarged, the finger inserted, one or more stones found and removed with forceps and the viscus explored. A small electric bulb will permit excellent visual examination. If the wall is healthy, it may be sutured with chromicized gut introduced into the submucous coat, inverting the mucous membrane. The skin should not be sutured as a scar is of slight importance. Drainage of the bladder is advisable if purulent cystitis is present but is difficult in children. In purulent cystitis the suprapubic is certainly the advisable route of entrance.[1]

Perineal Lithotomy.—The LATERAL operation in experienced hands has always had strong advocates. It permits the ready extraction of stones of moderate size and affords excellent drainage. For infants it is the operation of choice. It is dangerous in the hands of one not familiar with the smallness of children's anatomical parts. Injury to the seminal ducts or the rectum, the tearing off of the bladder from the urethra in an attempt to stretch and dilate a too small incision, and lastly, failure to reach the bladder have occurred. The diminutive size of the prostate is confusing to an inexperienced operator.

The anatomical conditions to be considered in children are the relatively high position of the bladder in the pelvis, its mobility, the undeveloped character of the prostate, the small size and fragility of the urethra. The prostate must be incised, not torn. In infants, even the little finger is too large for entrance to the bladder and small forceps must be used.

The lateral perineal incision does not differ from the one employed in the adult, but the structures are so close that the cuts must be cautiously and judiciously made. Too far backward, a bulging rectum or the ejaculatory ducts may be injured; too far outward, the internal pudic artery; too far forward, the crura; too far inward, the bulb of the urethra[2] (Fig. 142).

In lateral lithotomy, it is exceedingly important that the staff is properly held and that it is not withdrawn until the surgeon is positive that the

[1] Willard, Archiv. Pediatrics, Jan., 1892.
[2] Willard, Phil. M. and S. Reporter, 1872, xxvii, 473, 528.

bladder has been entered. The point of the knife must not leave the groove of the staff until the small prostate is well divided. It is better to incise a prostate on the opposite side or use a lithoclast than to tear a large stone through the tissues, causing urinary infiltration and sepsis. An assistant steadying the bladder above the pubis may prevent uplifting.

The BILATERAL and the MEDIAN operations have also their enthusiastic advocates; the latter give less danger of hemorrhage.

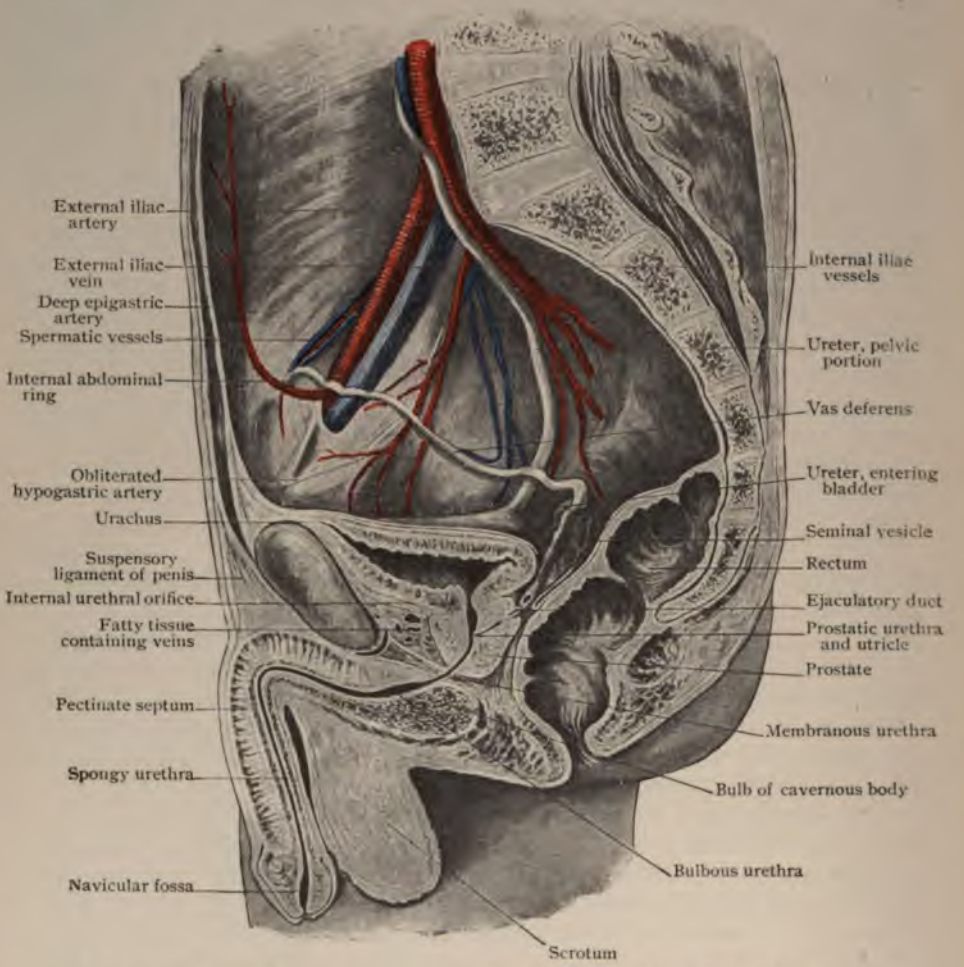

FIG. 142.—Anatomy of perineum, urethra, prostate gland and bladder. (Piersol's Anatomy.)

PERINEAL LITHOTOMY WITH LITHOLAPAXY is not advisable in children with large stones. Its advantages are chiefly due to the large drainage in old cases. The suprapubic route is better.

Hemorrhage, if arterial, should be checked by ligation. Subsequent hemorrhage, which is sometimes fatal, may be controlled by forceps left on for twenty-four hours or by attaching a gauze petticoat to a catheter and packing the inside with adrenalin or alum gauze.

AFTER TREATMENT.—After any form of lithotomy the child, unless an infant, may with advantage be placed on a raised bed-frame (p. 422) with opening opposite the hips, and the urine allowed to drip from the perineum into a receptacle beneath. After a few days the swelling of the wound will compel a portion of the urine to follow the urethra. Opium suppositories as needed and urotropin as indicated may be administered. Rest and confinement to bed will hasten the granulating process. Later on, occasional aseptic catheterization will assist in the formation of a new urethra.

Statistics.—The death rate in children is lower than in adults because the kidneys are in healthier condition. The general mortality given by White and Martin[1] is 2.22 per cent. From infancy to puberty, litholapaxy 1.7 per cent., perineal lithotomy 3.1 per cent., suprapubic lithotomy 13.1 per cent., but these last cases were undoubtedly the most unfavorable ones on account of purulent cystitis.

URETERAL CALCULUS.—Calculus of the ureter is rare in children. The clinical symptoms of hematuria, pain, tenderness and stoppage of urine should receive additional diagnostic proof by X-ray examinations by an experienced radiologist, by palpation through the rectum or vagina, by the cystoscope and by ureteral catheterization.

Removal by combined intra- and extra-ureterolithotomy should be employed[2] if free diuresis fails to dislodge the calculus.

SUMMARY.

1. Litholapaxy is the operation of choice in boys over two years of age with healthy bladders, if the calculus is not of large size or unusually hard. Recurrence is speedy if all fragments are not removed.
2. Suprapubic lithotomy is preferable for large stones and for any unusual complications.
3. Lateral lithotomy is the best operation for infants.
4. Lithotomy and litholapaxy are both dangerous in inexperienced hands. Reliable lithotrites are now made in children's sizes.

UNDESCENDED TESTICLE.

Synonyms: Cryptorchidism; monorchidism; ectopic testicle; ectopia.

A testicle, normal or imperfectly developed, may be arrested at any point between the kidney and the scrotum in its descent before the seventh month of fetal life, especially if its mesorchium is short. It may remain *within the abdomen* or be diverted from the normal course and rest in the perineum, the groin, or the pubis (ectopia), due to a false attachment of the gubernaculum. This condition occurs once in about a thousand children. A MONOCRYPTORCHID is an individual in whom only one testicle can be located; a DOUBLE CRYPTORCHID, or ANORCHID, one in whom neither organ is palpable. One or both testicles may be temporarily drawn within the canal by the cremaster muscle and the surgeon deceived. The author has

[1] White and Martin, Genito-Urinary Diseases.
[2] Gibbon, Surg., Gyn., and Obstet., May, 1908.

been called into the country to operate for undescended testicle when, under ether, both testes have been found in the scrotum. A testicle absent at birth may descend during the first year or many years later. The author has reported a case of spurious hermaphroditism, where the individual was classed as a woman until adult life, when both testes descended suddenly.[1] As congenital inguinal hernia is associated in one-half the cases, the anatomical conditions have been described already (p. 132, also p. 135) (Fig. 143).

A testicle lying within the canal or above the scrotum is much more liable to pressure and injury than when within the scrotum, hence inflammatory conditions are more common. In a double cryptorchid, the scrotum will of course be diminutive, having no office to perform. If both organs

FIG. 143.—*a*, common form of hydrocele testis. The tunica vaginalis propria is distended by fluid, and the parietal peritoneum runs smoothly over it. *b*, hydrocele testis, hydrocele funiculi spermatici, and inguinal hernia. The processus vagin. periton. has united in several places, and has in consequence formed several sacs lying one above the other. At the bottom of the scrotum is a hydrocele of the testis, above it two hydroceles of the spermatic cord, met above by the hernial sac. *c*, hydrocele communicans; secondary inguinal hernia. In consequence of an *incomplete descent of the testicle*, the union of processus vaginalis is defective. A hydrocele communicans has developed, which is simultaneously the seat of a hernia. This condition is also called hydrocele hernialis. (Pfaundler and Schlossmann.)

are displaced, the adult is likely to be sterile. An undescended testicle is usually imperfect in development and only occasionally capable of secreting spermatozoids, consequently when one testicle is perfect the entire removal of a badly developed one has no effect upon the fertility of the individual and its retention need be considered only for cosmetic and mental effect. If the testicle is moderate in size and consistence, it is better to make the attempt to locate it in proper position, since it may possibly develop and will add to the comfort and pride of the owner. If the testicle is situated in the perineum it may be withdrawn and anchored in the scrotum. The undoubted susceptibility of imperfectly formed tissues to sarcomatous degeneration should be considered. The per cent. of reported cases of sarcoma is very considerable in adults.[2]

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[1] Willard, Trans. Obstet. Soc., Phila., 1872.

[2] Annals of Surgery, Dec., 1904; Eccles, Lond. Lancet, clxii. 569, 722.

Treatment.—As descent after birth is not at all uncommon, no treatment is advisable in infants. Up to the age of ten or eleven, operation may be delayed unless strangulated hernia occurs, since the majority of these misplaced organs will make their way to the scrotum before the age of puberty. When puberty approaches and one or both organs are still retained in the abnormal position, transplantation becomes advisable, especially if hernia coexists, lest the individual be sterile. Gentle massage and traction may be instituted early, sometimes with the result of bringing the organ into the scrotum without injury to the structure. If puberty is reached with the testicle still within the canal, the organ will seldom develop normally. The influence of these organs in both physical and mental development of the individual should always be considered, and neither in single nor in double cryptorchidism should they be removed during early childhood.

ORCHIDOPEXY.—Before puberty, if hernia coexists, and with a testis lying in the canal, a radical operation will permit the cure of the former condition and a probable drawing down and fixation of the organ in the upper part of the scrotum, from whence it may slowly descend to the normal position. The cord is lengthened by dissecting away the cremaster muscle and all connective-tissue bands except the artery and vein. A pocket is made in the scrotum and the testis stitched to the bottom of this cavity with well chromicized gut. If the organ in large adolescents is atrophied and undeveloped, removal (*orchidectomy*) will not effect fertility. A celluloid testicle is excellent for cosmetic and mental effect.

AS HERNIA in greater or less degree is usually present, the inguinal canal may be slit up as in the Bassini operation. The testicle is then drawn down and the sac separated from the cord as high as the internal ring. This requires a tedious and careful dissection. The sac is isolated and tied as high as possible. Carefully avoiding injury to the blood-vessels and vas, the cord is freed above and the testis drawn as low as possible toward the scrotum and anchored to the bottom by chromicized gut. The inguinal canal is closed as in hernia by suturing muscle and fascia to Poupart's ligament (see Hernia, p. 141), the lower stitch being placed to narrow the external ring as much as is compatible with the safety of the cord, thus preventing retraction of the testicle into the canal. The canal in young children is sutured without transplantation of cord. Anchorage is condemned by some surgeons, but in the experience of the author it has added a not unimportant amount of traction and similar to that exercised in fetal life. Bevan advocates searching for retained testicles even within the abdominal cavity and the sacrifice of veins and all restraining tissues.[1] He argues that as the vaginal process of the peritoneum is the principal obstacle to reduction, it should be transversely divided and the testicle brought down and anchored in the scrotum, the lower end of the vaginal process being sutured about it to form a new tunica vaginalis testis. The cord is carefully dissected and wiped with gauze until a testicle even as high as within the abdomen can be brought down into the scrotum. In a few cases the spermatic artery and veins may be so short as to require

[1] Trans. Surg. Sec. Amer. Med. Assoc., 1903, 540.

subsequent supply of the organ being entrusted to the artery
he vas.[1]
nay assist in preventing recedence and if the organ remains
ion below the pubis, the patient should be satisfied.

HYDROCELE.

e, or an accumulation of serum in the normal tunica vagi-
s common in boys of any age, even in infants. In girls, a
he canal of Nuck may occur.
AL HYDROCELE arises from the accumulation of fluid in an
congenital peritoneal pouch.
E HYDROCELE occurs when the upper portion only of the
ess of the vaginal tunic has been closed.
AR HYDROCELE OF ENCYSTED HYDROCELE OF THE CORD is pro-
effusion in a non-obliterated central portion of the funicular
uid being shut off both from the peritoneum and from the sep-
lar tunica vaginalis (Fig. 143 *b*). If the canal is partially open
moderate succussion during crying (Hernia, p. 135).
.—A true hydrocele may be diagnosed from a hernia by the
s non-reducible upon lying down; is more firm and elastic;
form at the bottom of the scrotum, not at the base; if
, and when lifted falls back as if hinged at the base; and is
hen a light is placed behind it and the surgeon views it through
or partially closed hand. Following acute traumatism or in
gic form of periorchitis (chronic hematocele) or in thick-
orchitis prolifera) the latter test will fail. In hydrocele the
s can be felt at the base of the tumor; in hernia, they are

t.—Hydrocele in very young children is usually curable by
aseptic TAPPINGS with trocar and canula, under local anes-
uncturing the tunica vaginalis, the sac must be made tense
ar made to point directly backward and upward, since the
the lower posterior portion of the scrotum. The puncture
ed with aseptic cotton and collodion or with compound
nzoin. The tapping may be repeated if necessary.
ele of the cord can usually be cured by tapping and the appli-
pressure of a truss in a young child, provided the diagnosis is

N.—RADICAL CURE.—In recurring cases, incision is safer than
jection of pure carbolic acid or tincture of iodine should not
unless it is certain that the internal abdominal ring is closed.
boys if the effusion is persistent, fifteen drops of tincture of
w drops of carbolic acid may be injected after total withdrawal
The external ring should be closed with the finger lest the
unobliterated. The scrotum is manipulated until the iodine
uted over the sac. The iodine is not diluted nor withdrawn
In larger boys and large hydroceles, a drachm may be re-

[1] Keen's Surgery, iv, 595.

quired. While detention in bed is safer after injection, self-supporting boys can sometimes resume work in a couple of days if a suspensory is worn. Iodine is more painful than carbolic acid but is less likely to produce sloughing. Marked swelling and hardening of the scrotum is common after injection but this swelling will usually subside in a few days if rest is enjoined and the scrotum supported. In case of recurrence, a second injection will be successful.

EXCISION.—Excision is rarely required in childhood except in large boys, when if the boy can afford two weeks of rest, excision of the sac is the more certain of cure.

The tunica vaginalis may be incised aseptically, inverted over the testicle, and sutured with catgut around the organ. The deep fascia is then stitched and closed (Ochsner).

EVERSION OF THE TUNIC.—After aseptic incision of the sac, under local anesthesia, the testis is forced out of the opening and the tunica vaginalis everted. A pocket for the testicle is then made by blunt dissection beneath the skin of the scrotum. When the organ is placed in this pocket, it is slightly rotated so that the cut edge of the tunic on the outer side can be sutured to the inner raw surface of the inner lip of the everted skin. The outer layer of skin is then sutured separately. Andrews makes a small opening in the very tip of the upper end of the sac, and pushes the testicle through the slit. This buttonhole encloses and fits tightly around the cord as the sac is everted, leaving the organ outside of the sac and speedy healing is secured.

Resection of the entire parietal layer of the tunic is rarely necessary in boys, as the membrane is seldom thickened.

Incision and stitching of the parietal layer of the tunic to the skin (Volkman) and packing is dangerous, as it is difficult to maintain aseptic dressings.

TOTAL EXCISION is best accomplished by carefully dissecting the tissues without rupture of the sac, the globular mass rendering the dissection easier. If the sac is open to the abdomen, it is separated from the surrounding structures, drawn down, ligated and cut away, and the inguinal canal sutured.

After any of the operations, with or without drainage, the patient must be confined to bed for two weeks.

Hydrocele of the canal of Nuck in girls should be treated in the same manner.

CONGENITAL MALFORMATION OF THE KIDNEY.

Congenital absence of one kidney[1] is usually unrecognized until the condition is disclosed by cystoscopy or ureteral catheterization or during a celiotomy. The HORSESHOE kidney is not uncommon and e ther kidney may be displaced from its position.

As a rule, surgical interference is not called for until some complication arises.

[1] Willard, Amer. Jour. Med. Sci., 1870, 453; Trans. Phila. Path. Soc., iii, 1869, 170.

KIDNEY SARCOMA.

sarcoma of the kidney is not infrequently congenital in origin.
rare. These tumors when existent are usually adenosar-
ably springing from the Wolffian bodies. The growth may be
dle-celled in composition, its origin be ng in the cortex or in
he tumor usually develops before the age of five.
ence of a steadily increasing tumor in the loin, hematuria,
and cachexia are the chief symptoms. The tumor can usually
nd may be smooth or lobulated, and although solid, sometimes
sation of fluctuation if ascites is present. In a patient of the
circumference of the abdomen was twice that of the chest.[1]
s. — The tumor may be confounded with hydronephrosis,
oid or sarcoma, retroperitoneal sarcoma, or tumor of the
n.
t. — Early postperitoneal nephrectomy, although it has a
0 to 70 per cent., offers the only hope of relief and has been
several cases.[2]

NEY, FLOATING, MOVABLE, OR WANDERING.

kidney is occasionally met with in adolescent girls. It is best
by the operation of fixation,[3] but by attention to the general
applying a support five to seven inches wide made by zinc
e plaster strips, encircling the entire body. These should
while the patient is supine and should run diagonally to
support the lower abdomen.[4] If the plaster irritates too
e or Storm abdominal bandage may be substituted (Fig. 87,

l dyspeptic and neurotic symptoms will be present from lack
alanced intra-abdominal pressure.
ive bandages fail to relieve and actual symptoms with crises
usual operation of NEPHROPEXY may be done either by sutur-
g with gauze (Deaver), or capsule splitting.

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nd Steele, Amer. Jour. Med. Sci., Mch., 1900; Trans. Phila. Coll. Phys.,

ans. Phila. Pediatric Soc., 1906, ii, 15; Jacobi, Trans. Internat. Cong., Co-
; Levi, Arch. Pediatrics, 1896; Abbe, Annals of Surg., Jan., 1894; Gibbon,
cad. Surg., 1909, 216; Annals of Surg., 1908, xlvii, 1059; Rush, Archives
., 1908.
a, Penna. Med. Jour., Nov., 1907, 118.
enna. Med. Jour., June, 1909, 744.

CHAPTER VI.

BURNS, FROST-BITES, BOILS.

BURNS AND SCALDS.

YOUNG children are exceedingly liable to suffer from burns, owing to their ignorance of the danger of fire and their inability to extinguish the flames. Instead of wrapping themselves in a blanket they are more likely to run screaming to the mother. They are also frequently scalded by falling into tubs of hot water or by upsetting kettles. The most serious internal burns are from inhaling steam, or from swallowing lye (p. 105) which resembles milk, or from taking carbolic or other acids.

Prognosis.—The prognosis is most unfavorable if the destruction of tissue is deep or the surface large. If one-quarter or more of the trunk is burned even superficially, the child will probably die. Death occurs primarily from shock and from the loading of the internal organs with toxins from the blood-corpuscles which have been altered by heat; later from tetanus, bronchopneumonia, erysipelas, meningitis, sepsis, or exhaustion. Deeper burns of the second or third degree in young children are liable to be followed by gangrene, necrosis, large sloughs and death. Even if a line of demarcation forms with final separation of slough, there is great danger from systemic infection unless strict antisepsis is secured. Perforation of the duodenum sometimes follows.

Treatment.—The first indications are to relieve shock, lessen pain, exclude air and secure asepsis.

SHOCK.—Wine or whisky or morphine should be given by mouth or rectum or hypodermically and external heat quickly applied by hot water bags, or by electric mattress[1] or pad, or by an electric bulb on a wire from nearby socket, or by heated air.

After the clothing has been cut away, the burning external pain may be lessened by wetting the parts with a warm saturated solution of sodium bicarbonate and covering with waxed paper or oiled silk, but the patient must not be chilled. A child may be kept continuously in a hot soda or boric bath. For burns of the first or superficial degree, a half of one per cent. solution of picric acid gives quick relief. Flour or a bland powder and some form of oil or ointment are usually at hand and can be speedily applied, since the exclusion of air is very important to assist in repelling bacterial invasion.

STERILIZED DRESSINGS.—Sterility of the burned surface is of the first importance after primary relief of pain. When the child is in condition to receive ether, the blebs and all absolutely destroyed tissues should be quickly cut away, the parts irrigated with hot carbolized water 1:60, or

[1] Willard, Annals of Surgery, May, 1898, 682; Phila. Med. Jour., vii, 1901, 1070.

boric solution or dilute peroxide of hydrogen, and dressed with boric acid and petrolatum 1:10, or salicylic ointment 1:30, carbolized olive oil or petrolatum, or in fact with almost any mild antiseptic oil, provided air with its microörganisms is rigidly excluded by waxed paper or oiled silk. An antiseptic thick paste prepared from sterile oil and zinc oxide is excellent. Unguentine and resin cerate are also effective applications. In place of the white lead formerly used, a mixture of carbonate of lead, powdered acacia, sodium bicarbonate, and linseed oil is good; or linseed oil and lime-water (CARRON OIL) may be used. If there is much oozing, strips of rubber tissue will permit the exudate to escape into the superimposed antiseptic gauze dressings. Carbolic acid burns should be first neutralized by alcohol; burns from lime neutralized by vinegar. Perfect rest and quiet should then be enjoined and stimulation and heat continued. Opium and morphia and bromides should be given to the point of quietude from pain, and an

FIG. 144.—Transfer of plastic skin flap from leg to opposite foot.

abundance of water given even if there is vomiting. If the child is not too young, slow drop-by-drop rectoclysis is helpful in flushing the kidneys (p. 126). Dusting the part with stearate of zinc powder or the oxide of zinc and acetanilid 10:1 is comforting. Dressings should not be disturbed as long as they are inodorous, even though days elapse. Subsequent dressings consist in uncovering only a small area at a time, cleansing with carbolized solution, cutting away all dead tissues, and redressing with a mildly antiseptic ointment. Carbolic acid poisoning from dressings will show its toxic effect by greenish or black urine, feeble pulse, vomiting and coma. The dressing should be at once suspended, stimulation with alcohol and camphor commenced, and dry cups applied over the kidneys, with continuous rectoclysis. After all burns, water and fruit juices should be freely given and in a serious case the child should lie in a hot bath for hours. If the child survives, a long and tedious period of suppuration, granulation and contraction will follow. The child must be placed in the open air (p. 380) and food, tonics and stimulation freely administered.

Cicatrization and Contraction.—In large destruction of skin and tissues, dense cicatrices may draw the lip and chin almost to the sternum, or

evert an eyelid, or if uncontrolled, fix an arm to the chest at the axilla (Fig. 145), or flex a knee, or elbow, or wrist. These contractions must be avoided by compelling a larger deposition of granulation tissue, even if healing is delayed. Small and large skin grafts will greatly aid in prevention.

Splints.—An arm or leg must be fixed by splint or plaster of Paris (windowed for dressings) in a position the opposite to the one in which it is likely to be drawn and deformed. This position must be maintained for months if necessary, until the scar is well formed. Meantime the cicatricial tissue should be anointed daily and very gently massaged and stretched.

After the splint is removed, much can be gained by encouraging the child to use the member in motions that will gently extend the scar tissue. Well-regulated movements in a special gymnasium and the adaptation of exercises and sports to the particular case will be helpful.

FIG. 145.—Cicatrization of arm, chest and axilla from burns, improved by plastic flap from shoulder.

Fingers and hands burned by sliding down ropes or wires should be most carefully watched to prevent contraction.

Plastic Surgery.—The great obstacle encountered by the surgeon in the relief of old established cicatricial deformities (Fig. 146) will arise from the difficulty of obtaining healthy tissue for repair, since the surrounding parts are more or less infiltrated and a flap of condensed skin will probably slough. In a circumscribed burn, if a flap of healthy skin can be secured of sufficient size to close the area, the scar tissue should all be cut away. A Z- or compound Z-incision, as recommended by McCurdy[1] with removal of scar tissue and sliding and elongation of flaps, will sometimes yield sufficient new skin covering. In other cases, a portion may be removed, or a thin fold like the border of the axilla may be split along its entire apex, dissected back, and the skin incised at right angles on opposite sides

[1] Amer. Jour. Orth. Surg., Feb., 1909, 495.

of the ends of the primary incision. The parts are then stretched so as to slide the skin and give raw surfaces at either end. When closed, the wound will be irregularly Z-shaped. Covering can also be obtained by lateral relaxing incisions and inward sliding of flaps, or by various shaped sections with torsions or reflections of the base. The superficial blood supply of the area must be wisely considered. In the fingers, hand, forearm, elbow, and arm, if a suitable flap cannot be obtained from the neighborhood, the plastic covering may be secured from the thigh or hip in girls or from the abdomen or chest in boys. After dissecting out all scar tissue, in order to leave flexible edges for union, the member is brought to the side of the body, a large flap folded upon its base and the raw surface applied to the denuded surface of the injured part. Colored silkworm or black iron-dyed sutures are then inserted on the three free margins, the parts dressed aseptically with gauze and silver foil and the arm fixed firmly to the body with plaster bandage. At the end of a week this bandage is removed under ether, the base of the flap severed, stitched in proper position, and covered with compound tincture of benzoin. Its vitality may be tested before severing by pinching with forceps.

FIG. 146.—Extensive cicatrization after sloughing.

Sliding of the skin may be done in a curved line, or laterally or longitudinally. Flaps with bases may be turned or reverted or twisted. A flap may also be jumped over an intervening section of skin. In all flaps, one-third additional must be allowed for shrinkage, and for the first few months after operation the flap will appear to be too large.

When the cicatrix is at the back of the hand or arm, the member may be pushed BENEATH a bridge or double based flap, raised from the chest or thigh or abdomen. The bridge is sutured on two sides and the arm bound in position for a week with plaster bandage, after which the bridge is severed.

A careful study of the various methods of flap formation illustrated in Bryant's and other operative surgeries will well repay. A flap may be transferred from the calf of one leg to that of the other by fastening the limbs firmly together with plaster for a week and then incising the base of the flap (Fig. 144, p. 220). A double transference also is possible, for instance, from the leg to the arm, and then later from the arm to the face or neck.[1]

[1] Finney, Tr. Amer. Surg. Assoc., 1909, 298.

Splints, massage, and manipulations are persistently applied for months as long as there is any tendency to recontraction.

In extreme cases amputation of a finger or limb is necessary.

CHEILOPLASTY.—Eversion or ectropion of the lip following burns and sloughings (Fig. 147) from disease or trauma (Fig. 41, p. 49) is most troublesome and unsightly. To replace a contracted lower lip, various operations have been employed.[1] The flaps may be held in place by skewers or pins or by sutures. Only the finest silk or gut should be used and it should be well smeared with carbolated petrolatum.

When a certain degree of mobility exists, a V-shaped incision corresponding to the margins of the lip, elevation of the lip, and closure of the flaps below in form of a Y may relieve the deformity. When the scar tissue is dense but little can be accomplished. If a flap can be secured, the everted mucous membrane may be raised by an incision around its border through the skin down to the muscles, and dissecting up the flap. This flap is reflected and held in position by a long pin passed from one cheek through the flap and out through the other cheek. The points can be protected by gauze and accidental removal may be prevented by clamped shot. If good skin is available, flaps may be turned in to the raw surface from below, or large Thiersh grafts applied. The dressing may be salt solution and gutta-percha, or the wound may be LEFT EXPOSED TO THE AIR. Sometimes a flap may be jumped from the neck to the lip over an intervening ledge of skin and finally pared and adjusted.

FIG. 147.—Slough of lower lip.

SKIN GRAFTING. — Large areas of granulating surfaces, as on the abdomen or chest, may be covered with numerous small pieces of skin (Reverdin) snipped from the patient or from a kind donor, tiny toothed forceps and scalpel or special scissors being used. The grafts should only extend to the deep epiderm. The granulation wound must first be scraped to remove edematous granulations, then irrigated with sterile saline solution and hemorrhage arrested by drying and pressure. The grafts are covered with protective or rubber tissue or Cargile membrane, and a dressing of wet saline solution applied. Coarse netting soaked in gutta-percha in chloroform solution, or silver foil or dry powders are also useful. Pressure is applied over wax paper by cotton and bandage. The dressing should not be removed unless odor is apparent. The object of the procedure is to form little islands of new cutification from the epithelial cells (Fig. 148). Egg membrane, frog's skin, and other materials have also been used.

Large grafts (Thiersh) may be cut from a sterilized thigh by a sawing motion of a sharp thin razor and by stretching the skin by spatula or straight board and shaving the section through half the thickness of the skin (Fig.

[1] Jour. Amer. Med. Assoc., March 2, 1907, and Feb. 20, 795; Surg., Gyn., and Obstet., Dec., 1907.

148). Ollier's grafts are thicker and extend through the skin, as also do Krause's. The latter renders the part anemic by elastic bandage. The strip as it is cut is folded up on the razor under drop irrigation of saline solution and when completed is transferred on the razor to the new site, being drawn off the edge by a needle and carefully adjusted *in situ* without being permitted to curl. A circumcised prepuce may be thus utilized. Epithelium raised by a blister has also been used. The outer rubber protection may be applied in strips to allow oozing. If dead grafts are discovered at the primary dressing, they should be removed to prevent infection of others.

FIG. 148.—Result of skin grafting.

K e l o i d .— Keloid degeneration not infrequently appears in the scar tissue following burns. Thyroid extract, fibrolysin and other preparations, as thiosinamin, have been used with advantage.[1] The scar tissue may be gently massaged with cocoanut or olive oil.

COLD—FROST-BITE.

While extreme cold produces similar effects to those of heat, yet the method of production is different. Cold acts by constricting the muscular vascular system and producing anemia of the tissues from stasis which may be so great as to end in gangrene, while heat produces a hyperemia that may also end in gangrene. Hands, feet, and ears, distant from the central organ of circulation, are most readily influenced by cold.

Treatment.—The too sudden return to the internal organs of the blood-corpuscles altered by cold is injurious, a fact that explains the rationale of the treatment of first rubbing the frozen parts with snow, then with cold water, and the tardy return to a warm room, with stimulation by camphor and alcohol.

The succeeding treatment is conducted along the same antiseptic lines as for burns.

[1] Little, Amer. Jour. Orth. Surg., Feb., 1909, 518.

CHILBLAINS—PERNIO.

Chilblains are caused by too sudden exposure of chilled surfaces to the influence of heat, especially in debilitated or feeble children.

Treatment.—A great variety of substances have been used to relieve the burning and itching pain so common in this complaint. In some cases powders are most effective, in others, ointments. Stearate of zinc with aristol or carbolic acid or acetanilid are often useful. Opium and carbolated petrolatum likewise are comforting. Turpentine, iodine, tincture of cantharides and soap liniment 1:3; oil of peppermint pure; oxgall, iodine and glycerine, camphor and chloral equal parts, iodine petrogen and also electricity have all been found of service. A mixture of ammonia, turpentine and oil is comforting.

Wetting and chilling of the feet and standing on cold pavements are to be carefully avoided.

FURUNCLES—BOILS.

Boils are the result of an infection of hair or sebaceous follicles by microörganisms. The conflict of the resisting phagocytes results in the death of numerous cells, the production of a sloughing centre—the CORE—and the walling in of the débris by the protecting cells. When a Meibomian gland of the eyelid is affected, the condition is known as a STY.

Treatment.—The condition is usually due to a lowered resistive vitality that calls for tonics and fresh air, especially when a succession of these abscesses occur. The most speedy relief is a slight incision under local anesthesia, curetting of the débris and the application of a Bier suction cup, followed by a drop of carbolic acid carried into the abscess on an applicator or by a hypodermic syringe. A sterile dressing is then applied, which will often entirely check further trouble. In all cases the urine should be examined and if sugar is present appropriate treatment should be given.

In chronic furunculosis, in addition to the above constitutional measures, VACCINE THERAPY in accordance with the organism found in the pus, as aureus or albus, should be practised.

CHAPTER VII.

ORTHOPAEDIC SURGERY.

AEDIC surgery is that branch of general surgery which includes
on and cure of distortions and deformities, both congenital
, that require not only the application and employment of
ods but also the adaptation of mechanical appliances, together
l development for the correction of deviations of form and
of the effects of disease or injury.

n orthopaedic undoubtedly originated from ὀρθός straight and
ljective of παῖς (παιδός) child. From the rectification of the de-
hildren the term has been enlarged to include the straighten-
nities at all ages. It is especially important that *paed* be
he English spelling, since in the minds even of physicians,
y of laymen, the unwarranted spelling *ped* is misleading, sug-
feet only are to be corrected. If this latter were the real
would have been necessary to have coined the hybrid word of
nd Latin pes (*pedis*). The pure Greek *orthos* and *paid* (geni-
gives us *orthopaedic*. An excellent derivation would be ὀρθόω
"to educate straight" but this would give orthopaedeutics, a
word. Orthosomatics (σῶμα, body) would be preferable. The
comes from the Anglo-Saxon CREOPERE a creeper.

iding line between orthopaedic and general surgery is not
ie nor can any sharp distinction be drawn between this
rgery and that of the neurologist. The orthopaedic surgeon's
consequently must lie largely in consultation with the sur-
e neurologist as well as with the internist and the general

opaedic surgeon needs first of all a thorough training in clini-
ative surgery, to which must be added the special knowledge,
skill required for the adaptation of mechanical measures in
n and cure of the various distortions and deformities. He
e acquired a practical knowledge of the benefits to be secured
development by gymnastic and similar movements, and in
have a thorough understanding of many nerve conditions.
therefore be a surgeon, a physician, a neurologist, a physical
a mechanician. He must also be an immunizer, taking
the benefits of vaccine therapy and all other aids to surgical
Above all he must recognize the fact that success in treatment
ly by assisting the recuperative and resistive powers of the
y combating them. He must possess common-sense, operative
entive ability. He must be prepared to encounter some of
us operative procedures, difficult in execution and dangerous
late excisions of the hip with large involvement of the pelvic

bones and in laminectomy and other conditions. He needs to possess great strength and endurance, since many conditions require forcible correction—brisement forcé—and hand pressure is much safer than any mechanical appliance. The intelligently trained hand and brain of a wise surgeon, recognizing the amount of force required, will prevent many accidents. Unintentional fractures, the tearing off of epiphyses and the rupture of blood-vessels are usually the result of force inaccurately applied. A twisting motion is the dangerous one in bone surgery.

The most discouraging part of an orthopaedic surgeon's work is the fact that a large proportion of his cases come to him with disease and deformity so far advanced that, although he may apply the highest amount of skill and dexterity, the final result will still be so crippling as to be a great trial and handicap to the patient and be always in evidence. Surgery of the internal organs, on the contrary, in its results is seldom apparent to the public after a few weeks.

The patience and the time required for examination, diagnosis and treatment of a large majority of orthopaedic cases renders them exceedingly liable to be neglected by the general surgeon. In a large general hospital, these patients are certain to be overlooked in the rush of active surgical work as their diseases, being chronic in character, require many months of careful attention and wise management. The general surgeon errs in considering that operative measures are sufficient for relief, since operation is often but one step in a long and tedious application of subsequent mechanical, gymnastic and hygienic measures.

The MECHANICAL ORTHOPAEDIST differs from the true orthopaedic surgeon in that he ignores the speedy and efficient benefit to be secured by well-directed surgical procedures. The former depends upon painful, tedious mechanical measures for a long time in the correction of deformities that can be straightened in a few moments by a well-planned operation. The term ORTHOPAEDICS is a misnomer; ORTHOPAEDIC SURGERY is the correct designation of this special science and art. The true orthopaedic surgeon is the one who judiciously and wisely combines all the methods above mentioned as applicable to the needs of the individual case.

The majority of deformities affect the hard parts, as bones and joints, but paralyses, muscular contractions and relaxations, cleft palate, etc., furnish numerous instances where both hard and soft parts are involved.

The time is not far distant when fractures and sprains, which are often the *bête-noir* of surgeons, will be referred to the orthopaedic surgeon for the benefit of his careful, patient mechanical and surgical skill.

A CHAIR OF ORTHOPAEDIC SURGERY is now an established part of the education of the medical student in all the prominent colleges.

In a number of hospitals special MACHINE SHOPS have been established for the manufacture of orthopaedic apparatus under the direction of the surgeon so that this important part of the treatment need not be referred to an untrained mechanician.

A SPECIAL ORTHOPAEDIC GYMNASIUM for the treatment of ankylosis, paralysis, stiffening after fractures, lateral curvature, flat-foot, muscular weakness, rickets and various other conditions is very important. Such an equipped gymnasium is seen in Fig. 151 and Fig. 152.

of Deformities. — CONGENITAL MALFORMATIONS. — Develop-
ts are exceedingly common owing to non-union of embryonal
e median line, as seen in hare-lip, cleft palate, and spina bifida;
ted development as noted in malformations of the genital and
rgans, to deficiencies in growth of bone, to intra-uterine am-
om bands or amniotic diseases, or to intra-uterine trauma or
ccurs in club-foot.
MA of the ovum in its first plastic month of development, even
t coition, may be sufficient to so derange the controlling nerve-
fective formation in some region of the body will be the result
ritional disturbances in germ-cells.
TY.—Hereditary influences extending through several genera-
rmities are so common that they are universally recognized.
nesses are likely to be transmitted by consangu neous marriages.
eurotics marry, spastic or defective children may be expected

NAL IMPRESSIONS.—While extreme fright, lightning storm or
ted illness during pregnancy may have its effect in produc-
c or a feeble child, the many peculiar coincidences of malfor-
not the result of mere maternal impressions. The only time
a mental effect could produce a positive influence upon the
be in the first embryonal month and then only by impress-
nerve-cells to such an extent that formative supervision is
The fanciful supposed resemblance of the malformed infant
erved object is studied out by the mother AFTER its birth,

of Acquired Deformities.—Tuberculous and infective joint dis-
, osteomalacia, osteo-arthritis, and arthropathies have a marked
production of deformities. The distortions of rickets, when a
lowed to walk or sit during the stage of softening, are found
of the body, producing lateral curvature, deformities of the
les, thorax or legs. Muscular contractures, paralyses and
r conditions enter markedly into the causes of back-knee,
ipes, etc. Spinal neuropathic conditions, as tabes, central or
erve irritation, muscular dystrophies, are frequently produc-
mities. Injuries of the epiphyses; sprains, fractures, exostoses
posits, rheumatoid, gonorrheal and infectious arthritis; callus,
ther fibrous, bony, or tuberculous, and trauma from any
listort the skeleton.[1] Occupational conditions resulting from
ing, static and attitudinal positions, inequality of limbs and
aknesses serve to make irregularities of form and figure almost

al classification of orthopaedic conditions may be tabulated
nodified from Young [2]):

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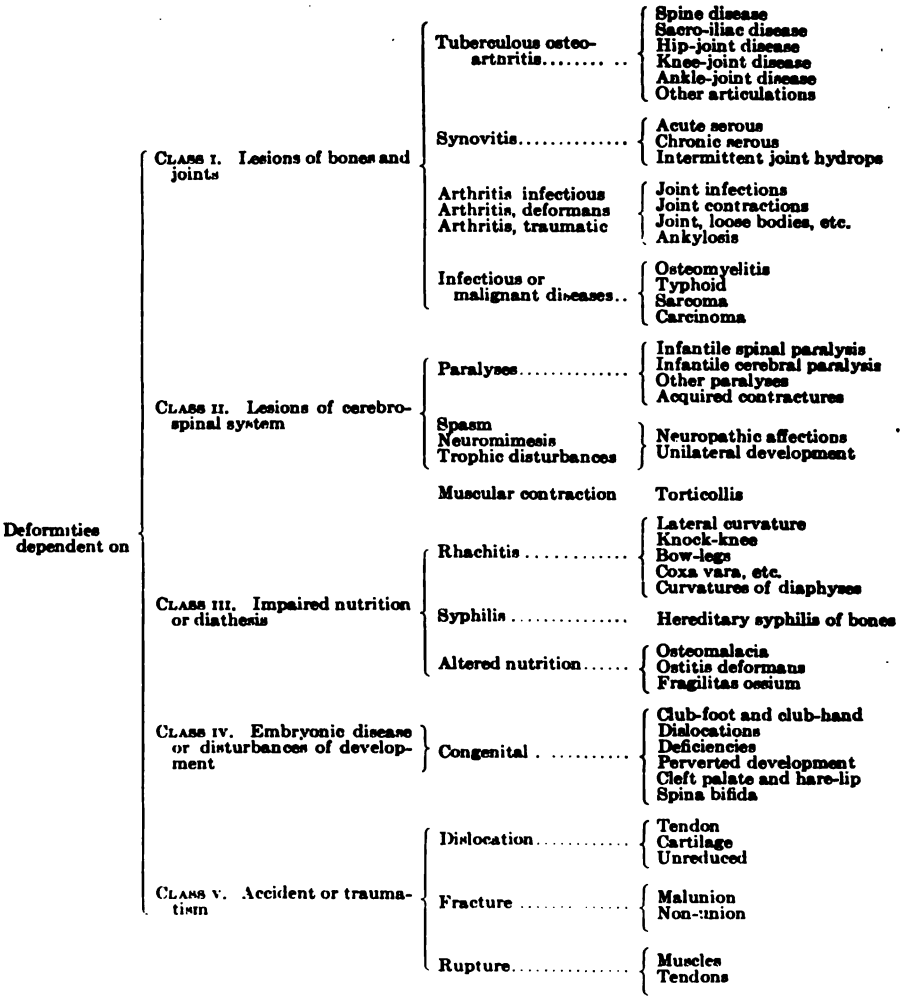
and Taylor, Trans. Amer. Orth. Assoc., 1902; Amer. Jour. Med. Sci., Dec.,
esetz. d. Transformation d. Knochen, Berlin, 1892; Archives f. klin. Chir.
Volkmann, Pitha u. Billroth's Chirurg., ii, Abt. 2, 693; Virchow, Archiv.,

Orthopaedic Surgery, 1905, 91.



Röntgen Ray in Orthopaedic Surgery.—The necessity for the use of the X-ray in diagnosis and in treatment has already been discussed (p. 4).

In orthopaedic surgery the Röntgen ray shadowgram is absolutely essential and will solve many otherwise obscure conditions in bone and joint diseases. In deformities this additional means of indicating the exact position and shape of osseous structures, their absence or deficiency or distortion, is of the greatest value. In spinal caries, sacro-iliac and other serious joint diseases, the Röntgenogram by advancing the time of diagnosis adds greatly in determining treatment.[1] The benefit to be obtained from such records is invaluable in tuberculosis, since a focus can be early detected and removed. Later the amount of bone and cartilage destruction and ankylosis can be clearly evidenced. The X-ray may also be employed to demonstrate the progress toward recovery or destruc-

[1] Leonard, N. Y. Med. Record, Nov. 17, 1906.

relative translucency of the diseased area, compared with
ords. Bone atrophy, irregular bone contours and mottling
re suspicious conditions in tuberculosis. Accumulations of
e carious vertebræ and in the psoas muscle can be outlined
s. In knock-knee, coxa vara, congenital dislocations, frac-
piphyseal separations the value cannot be overestimated.
ritis and rheumatoid arthritis a comparison of diseased joints
ted articulations will show marked differences. Children's
e very cartilaginous.

are so frequently associated with fracture, and errors in diag-
ommon and so disastrous both to patient and surgeon, that
ould receive most careful investigation. An X-ray examina-
al many an unexpected bone lesion and is particularly advisa-
joint region has been injured; when unobtainable an anes-
atly assist the diagnosis. Crepitus is an uncertain sign, as it
t in fracture and present in joints where there is only slight
s or synovitis. Epiphyseal injuries and separations are very
when there is much swelling are overlooked unless a skia-
n.

e it is essential that the operator of the Röntgen apparatus
competent, after which the interpretation of the shadow is a
ing close observation and study by the surgeon who must be
quainted with NORMAL RÖNTGEN RAY ANATOMY (pp. 7 and 8),
is all too much neglected and leads to many errors. Bone
well be studied in pathological specimens by the X-ray [1] as
ious diseases.

CHILDREN'S ORTHOPAEDIC HOSPITALS.

tly equipped children's orthopaedic hospital should have first
lant SUN-PORCHES (solaria) or ROOF-GARDENS accessible by
Separate wards for tuberculous joint cases, a specially
INASIUM, a SHOP for the manufacture of apparatus, and sepa-
layrooms are essentials.

rranged like the teeth of a comb should be so widely separated
and free exposure to air are secured. Offices and seldom used
hen be on the north side of the cross building and rooms
reater service can face south. The wards, with large windows,
ast, south and west, with sun-porch at the south end large
ommodate 20 beds. Every bed should have five-inch rubber-
o facilitate its being rolled out to a porch having no thresh-
progress. Upon this porch should remain night and day all
oint cases. The open sides should be protected from the glare
the summer sun and thunderstorms by awnings. Japanese
n curtains are easily obtained.

excellent construction which is also applicable to private house
have wooden panels, to the height of the mattress on the beds,

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Med. Research, vol. xi, No. 2, May, 1904; Univ. of Penna. Med. Bull., Jan-

to protect from wind. Above this level, stationary glass sides one foot high are inserted to permit bed patients to look out upon grass and trees. Above this line each alternate glass door extending to the ceiling should swing inward flat against its neighbor, or inward from its upper border, to permit permanent wire screening and avoid the dangerous mosquito and fly.[1] The glass sides can be removed in summer and reinserted in winter when the porch can be heated to allow large entrance of fresh air and yet not be too cool. It is fresh air that is needed, not necessarily cold air (Fig. 150, p. 233).

A child compelled to lie upon its abdomen will be much more contented if the bed is reversed so that he can see the other children in the ward.

It will be of great interest and enjoyment to the little sufferers as they lie in bed, to study and enjoy walls that can be inexpensively decorated with smooth aseptic tiles illustrating lively and pleasing pictures. These DECORATED TILES are as smooth and germ-proof as the white variety and will be of constant interest.

The walls should be tiled to the height of five feet, the tiling to be finished with arched top, not flat ledge, in order to prevent the accumulation of dust. Above the tiles enamel paint is best. Window casements should slope downward to prevent children from climbing upon them; outward laterally to admit more diffused light. All dust-accumulating angles should be rounded and abundant artificial ventilation provided. The floor must be smooth but not slippery. After smooth planing it should be dressed with a mixture of equal parts of turpentine and linseed oil, with japan in the proportion of 1 pint to the gallon of the mixture. This gives an excellent surface which is easily kept clean by simple wiping and will require only occasional renewal. A varnished or oiled floor is too slippery for cripples or for crutches, and fractures of the limbs have often resulted from too smooth flooring.

The operating, sterilizing, dressing, and clinic rooms should have floors of large blocks of white marble two feet square, not tiles, as the latter have more cracks. A SPECIAL ROOM where surgical dressings and manipulations can be done is essential, since if done in the ward cries of pain will distress the other children and retard recovery.

Patients requiring spine, pelvic and hip dressings should be kept upon bed-frame trays (Fig. 366, p. 424). These trays when placed on trestles (Fig. 367, p. 425) in the dressing room can have beneath them a large basin opposite the pelvis to receive flushings through a gap in the canvas coverings.

An ISOLATING ROOM is essential for the reception of any suspicious case of contagious disease, the immediate removal of which from the ward will often prevent an outbreak of infection.

A WARD FOR DETENTION of newly admitted children will also save from exanthematous diseases which are the bane of surgeons.

No patient should be returned to the general ward after operation until THOROUGHLY RECOVERED FROM ETHER, and quiet detention in a recovery room for twenty-four hours is advisable.

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[1] Willard, Open-Air Treatment of Surgical Tuberculosis, Trans. Sixth Internat. Cong. of Tuber., Washington, 1908, vol. ii, 257, Section iii; Jour. Amer. Med. Assoc., July 18, 1903, Sunshine and Fresh Air.

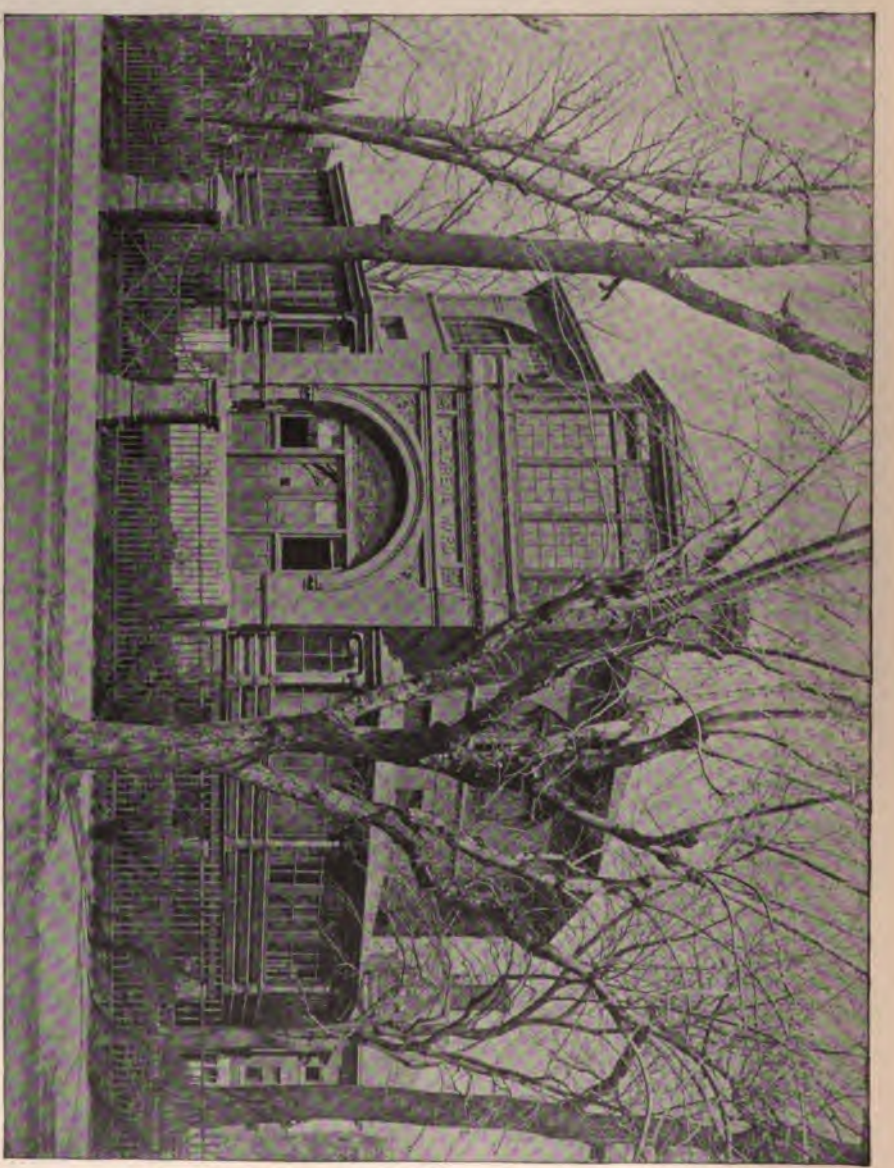

FIG. 149.—Children's Ward, Presbyterian Hospital in Philadelphia. Porch, glass enclosed in winter, open in summer; beds rolled easily from ward. Playroom in second story. Sunny lawn at side.

Fig. 150 shows Ward of the author at the University Hospital.[1]

Muscular Development Room or Gymnasium (Fig. 151).—The gymnasium should be in charge of an experienced and enthusiastic instructor, educated in physical training and in massage. Active and passive muscular movements, Swedish exercises and appliances, dumb-bells, double trapezes, rings of unequal height, quarter circles, and chest weights are all of service in paralysis, lateral curvature and other distortions. Young children must be interested and controlled by attractive exercises (Fig. 153).

For paralytics and for the education in walking of patients after operation, a TROLLEY TRACK extending the length of the ceiling should be pro-

FIG. 150.—Children's Orthopaedic Ward, University Hospital. Sun-porch at south end occupied night and day by patients; open in summer.

vided, from which the child can be suspended (Fig. 152, *A'*) with feet just touching the floor, while weight is borne by the adjustable leather corset (Fig. 152, *A*). The trolley travels on overhead wheels (Fig. 152, *E*).

Apparatus Shop.—A MACHINE shop and a SHOE shop under the direct supervision of the surgeon will give him an opportunity to have apparatus properly constructed without trusting to an unskilled workman.

Teaching. — Convalescent patients should have happy employment by regular daily short instruction in simple studies, in reading, writing, arithmetic, sewing and singing. Bed cases can be interested and amused by a teacher who will relieve restlessness and pain by stories, games, etc.

With an abundance of sunlight, fresh air, nutritious food, cleanliness and cheery surroundings, a children's ward is a bright and happy place.

Careless, indigent and indifferent cases after discharge from the ward

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[1] Willard, Trans. Amer. Orth. Assoc., xi, 456; Univ. Med. Mag., xiii, Sept., 1900; Lond. Nursing Record and Hosp. World, Feb., 1902; Widener Industrial Sch. for Crip. Children, 1st & 2d Ann. Report, 1907–1908; Amer. Med., Jan. 24, 1903, 148.

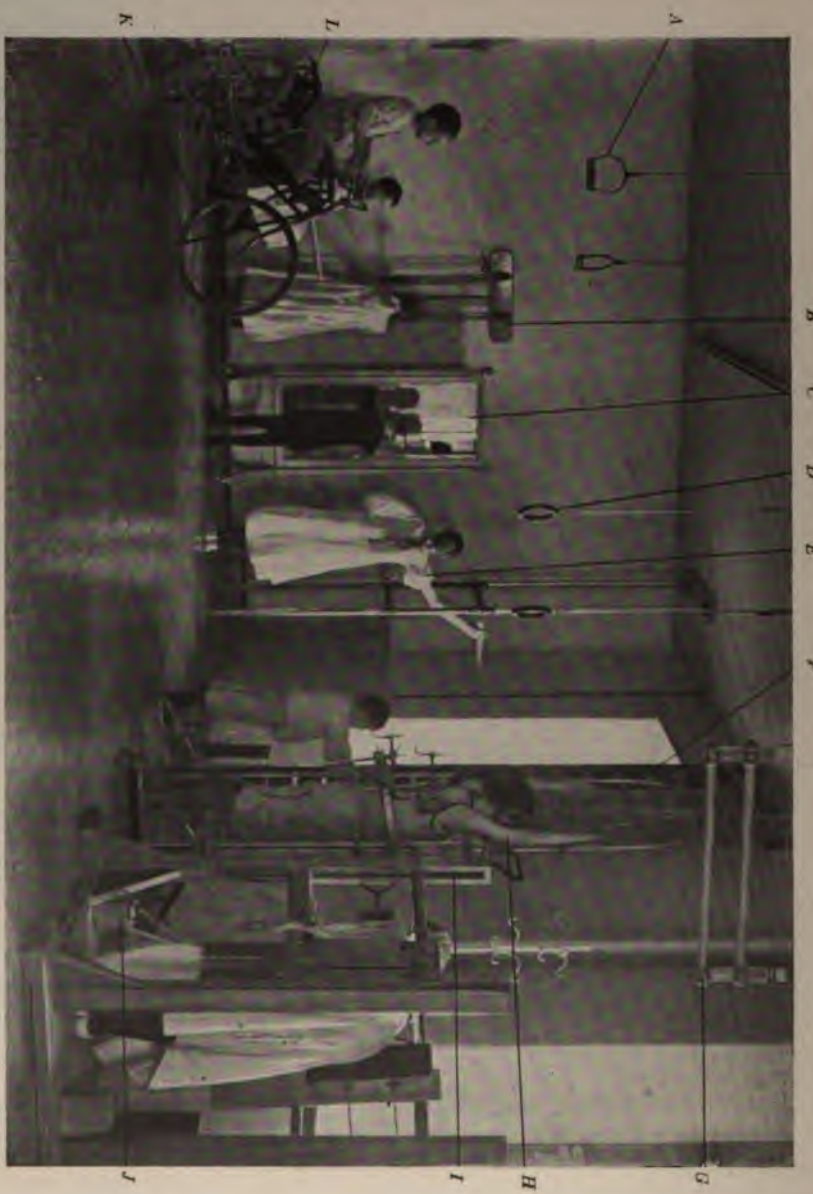

FIG. 151.—One end of Orthopaedic Gymnasium, University Hospital. *A*, hand rings; *B*, chest weight; *C*, mirror; *D*, uneven rings; *E*, fulcrum for lateral curvature treatment; *F*, Swedish side-bar ladder; *G*, double-bar trapeze; *H*, forcible correction apparatus for lateral curvature; *I*, forcible correction by weights in bent posture; *J*, weights; *K*, stationary bicycle for paralytics; *L*, vibratile massage.

FIG. 152.—Orthopaedic Gymnasium, University Hospital. *A* shows leather suspension jacket for paralytics; *A'*, suspension pulley; *E*, overhead moving trolley suspending track for support of *A'*; *D*, hot-air oven; *F*, hand pieces for round shoulder exercise; *G*, neck pull; *H*, quarter circle backward flexion; *I*, Indian clubs.

should be visited and dispensary cases watched over through general SOCIAL SERVICE methods.

Medical Teaching.—In a hospital connected with a medical college, of course the patients should be utilized for instructing the students in this essential portion of their education, *i.e.*, the treatment of conditions that they will meet in the early years of their practice and that will prove most baffling and injurious to their reputations if undiagnosed or wrongly treated.

Educational Schools for Cripples.—The author is fortunate in having at the Widener Memorial School for Crippled Children in Philadelphia (Fig. 154) a place where these handicapped children under ten years of age can be received and retained until twenty-one. After needed surgical operations are performed, mechanical supports manufactured at the school are applied and gymnastic muscular development is given. Each boy or girl, according to mental or physical ability, is educated and trained.[1] At the age of twenty-one it is expected that each one will have acquired a manual or mental occupation that will render him or her in after life a self-supporting and self-respecting member of society, instead of remaining a dependent upon the community. Remunerative occupations will be chosen adapted to the individual's disability. An ordinary common school education will be given to all, a few with superior talents may be further educated in stenography, secretaryship work, instrumental and vocal music, art, etc. Much of the time day and night is spent out of doors and out-door occupations are encouraged. Nutritious diet is also an important factor in their health. Cottages accommodating 25 boys or girls are presided over by house-mothers in order to supply as far as possible the conditions of an ordinary household. Only children of good mental condition are admitted, but the physical handicaps are often extreme.

FIG. 153.—Stationary bicycle for paralyzed leg. Can be run voluntarily or by electric motor.

Forest Schools.—The out-door schools already established in this country and abroad are securing excellent results in health (p. 380) and open-air ROOF GARDENS in the cities are of great service on account of their ready accessibility.

Physical Training of Children.—The age of young childhood is the time to inculcate habits of correct posture, locomotion, attitude, etc. Neglect of care and training is the cause of many deformities and much ill health. Mothers need accurate instruction from a competent physician rather than from a prejudiced physical trainer. The normal conditions

[1] Willard, Amer. Med., Jan. 24, 1903, 148; 1st & 2d Ann. Reports Widener Memorial Training School, 1907–1908; Gill, Founders' Week Memorial Volume, Philada., 1909, p. 874; New York Med. Record, 1909.

FIG. 154.—Widener Memorial Industrial Training School for Crippled Children, Philadelphia. Cottages at four corners of Central Hospital Building connected by glass-enclosed corridors and open sleeping porches. Thirty acres of grounds for out-of-door work and play.

of a normal child should be the end desired.[1] Attention to general health is all-important, and great caution should be exercised during convalescence from exhausting diseases and at the age of puberty. Deviations of the spine are often overlooked by mothers until irreparable injury has been done, and deformities of feet and legs fail to receive proper recognition. The physical conditions require greater care than the mental, and school must be subordinate to out-door life and exercise. It is undoubtedly true that the school-room is often the producer of subsequent defects and invalidism.

Clothing.—Acquired deformities are more common in children than congenital ones. The effect of improperly fitted clothing is often seen in the flat chest, round shoulders and crooked backs of children, whose too tight clothing across the chest has constantly induced the stooping position and interfered with free expansion. The tight lacing of girls interferes seriously with the thoracic and abdominal organs that are so essential later in childbearing. Armholes in clothing should be wider in front than in back, wide enough to permit the shoulders to be carried backward without tension. Clothing suspended from the shoulders induces the stooping position. Tight garters interfere with the venous circulation of the legs. Sitting in chairs with legs dangling is conducive to deformities of both chest and spine. Free deep breathing means better oxidation of blood and better nutrition of body. The prone position for rest is helpful.

FIG. 155.—Cast of fashionable Chinese lady's foot.

Shoes.—Fashion that compels the wearing of ill-fitting shoes is responsible for nearly all of the acquired disorders of the feet from which the barefooted races are free. Moccasins and sandals are the only foot wear that permit the normal tread of the foot. Shoes should be straight along the inner side, with low flat heels and with full expansion for toes. The distortion of the foot made possible by tight bandaging is seen in the feet of fashionable Chinese women (Fig. 155).

WOLFF'S LAW OF FUNCTIONAL PATHOGENESIS, OR THE LAW OF TRANSFORMATION.—This law is based upon the theory that "every change in the form and function of the bones or of their function alone is followed by certain definite changes in their internal architecture and equally definite secondary alterations of their external conformation in accordance with mathematical laws." This theory adapted chiefly from the similarity of the internal structure of the trabeculæ of the head and neck of the femur (Fig. 156) to the trajectories of Culmann's diagram of the Fairbairn crane, lays too much stress upon the mathematical conditions and gives too little importance to the influence of the muscular forces on the greater and lesser

[1] McKenzie, Exercise in Education and Medicine.

trochanters The effect of muscular pull upon the lesser trochanter is positive. Freiberg and Taylor [1] have added greatly to our understanding of this theory. The strengthening and condensation of cortical substance upon the concave side of a bone is doubtless due not only to functional requirements but also to weight-bearing. The advocates of pressure or of its absence upon the condyles of the femurs in knock-knee or in scoliosis, in superincumbent weight-bearing, atrophy, and other conditions, have certainly strong arguments in their favor.

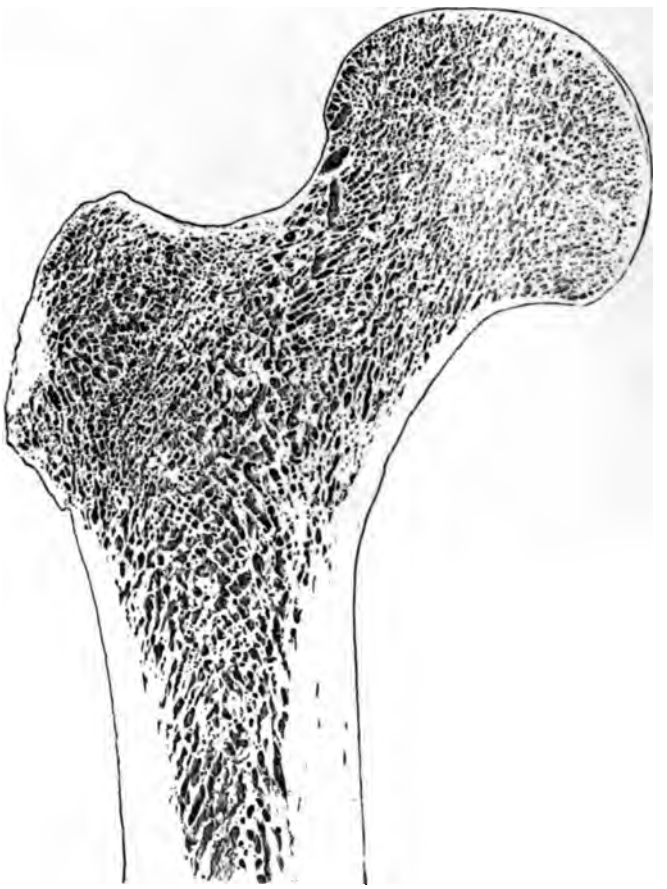

FIG. 156.—Section through upper end of femur, showing arrangement of pressure and tension lamellæ. (Piersol's Anatomy.)

After the correction of the deformity in club-foot, knock-knee and many other conditions, use, weight-bearing and function being thus brought into normal play will necessarily produce both muscular and bony changes. The enormous strengthening of the fibula when the tibia has been lost, for instance, enables it to bear the weight of the body. The compensatory strengthening of the cortical layer of a bent bone on its concave side is frequently noted.

[1] Annals of Surgery, July, 1897, p. 136; Amer. Jour. Med. Sci., Dec., 1902.

Interference with arterial supply or nutrit on, joint disease and long-continued disuse may not only atrophy the bones but make them exceedingly fragile and fracture may be the result.

Fig. 157.—Cork shoe, with apparatus for short leg.

APPARATUS AND BRACES.

Cork soles, when less than an inch of elevation is required, may be placed within the shoe, but when two or three inches are necessary, a more firm support for the apparatus stirrup is secured by building up the cork outside the sole (Fig. 157). Paralytics walk badly in the false equinus position of the "extension shoes," but for cases of shortening from hip disease or other causes where the muscles are strong, such shoes are less conspicuous.

Special Lasts for Shoes. — When possible, especially with adolescents, a special last should be constructed from a plaster cast. Cooke [1] has devised a plan by which the shoemaker can build a shoe directly over a plaster counter-cast.

A pelvic band (p. 626) is always cumbersome and should be avoided when possible. In infantile paralysis below the hips with flail legs, the necessity or non-necessity for pelvic support can be best tested by ascertaining the balancing power of the pelvis upon the thighs while the patient rests upon his knees. This pelvic portion of any brace should be made to be removable as soon as muscular power has been gained sufficient to permit locomotion without its support.

Buckles with sharp points are liable to wound and infect the hands of nurses. A better form is the suspender buckle with broad tongue.

A steel joint that has proven of great service, preventing the constant annoyance of ankle rivets tearing out and wearing so as to be noisy, is made as follows: The stirrup is forged to broaden at the joint (Fig. 158, *A*). From this stirrup is drilled a hole one-half of its width; into this opening is neatly fitted a circular disc of steel (Fig. 158, *B*). Another disc, *C*, of the diameter of the leg upright *D*, is made and the three pieces, *i.e.*, leg upright, circular disc and outside disc are joined together by three or four small rivets. Such a joint will last for years. A similar device is advantageous at knee or hip.

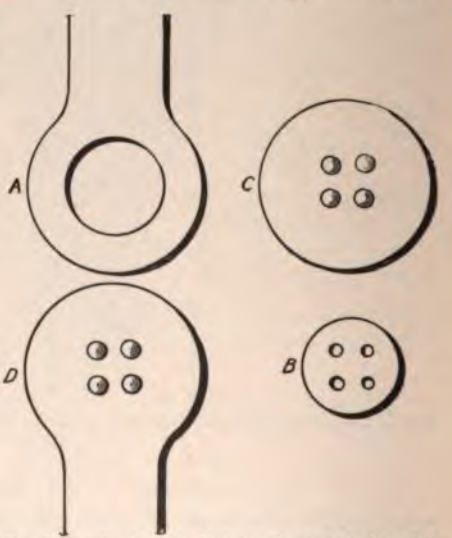

Fig. 158.—Steel joint. Holes in *B*: rivets in *C* and *D*.

[1] Amer. Jour. Orth. Surg., 1905, 417.

ADJUSTMENT OF APPARATUS.—No one without personal experience in the wearing of a brace can realize the pain and discomfort that even the best adjusted apparatus will give. Pain is often extreme from corns and callosities and pressure that sometimes even produces slough as for instance along the spine. Many a good brace is thrown aside because the surgeon has failed to realize that an adjustment of even $\frac{1}{16}$ of an inch with bending irons (Fig. 610) would have given relief. To apply a brace and at once discharge the patient is to invite certain defeat. When a brace is first worn, the rule should be that it should be on, only ONE HOUR THE FIRST DAY, TWO HOURS THE SECOND, and so on until the soft parts have become accustomed to the pressure. After each removal, REDDENED AREAS should be rubbed with alcohol and alum, then powdered and anointed. A bluish area means danger of sloughing through pressure, and the brace should be bent or adjusted. A PLEDGET OF WOOL tucked between the stocking and shoe each morning will lessen pain. The neck of a pad that is placed opposite the inner or outer ankle or knee to relieve pressure is liable to work loose or to break; this can be prevented by raising from the neck pedicle a flange lip on either side, to grasp the stirrup arm. The stem should be held in place by two rivets. ALUMINUM is light but brittle and is not as readily adapted to apparatus purposes as is steel. When several shoes are desired to be worn, expense can be saved by having a single apparatus for the leg made with DETACHABLE JOINT at the ankle, each shoe being supplied only with a stirrup. When corns and callosities give pain, a SKILFUL, CLEAN CHIROPODIST will give great comfort and is a necessity to any patient compelled to wear apparatus. In children the existence of these callosities is frequently overlooked and is the cause of much suffering (Corns, p. 717).

FIG. 159.—Thomas knee-splint cheap artificial leg.

FIG. 160.—Home-made peg leg.

Canes.—A cane should always be used in the hand OPPOSITE the weakened leg in order to secure two points of support for the body simultaneously and thus avoid excessive limping. An ebony or any stiff cane is liable to make the hand sore; a flexible bamboo is much better. The head should be of large size to fill the hand; a square right-angled top is not as comfortable as a rounded handle.

Crutches.—Every patient obliged to use crutches should be instructed to avoid paralysis of the arms from axillary pressure by straightening the elbows and taking the weight of the body upon the hands grasping the cross bar of the crutches. The distance of the hand-piece from the top should be properly adjusted to the length of the arms. Rubber tips are best.

A cheap artificial leg can be made by a Thomas walking knee-splint (Fig. 159) or by a wooden peg and strap (Fig. 160).

Instruments.—The principal instruments required by the orthopaedic surgeon, in addition to the ordinary scalpels, hemostats, retractors, etc., are as follows:

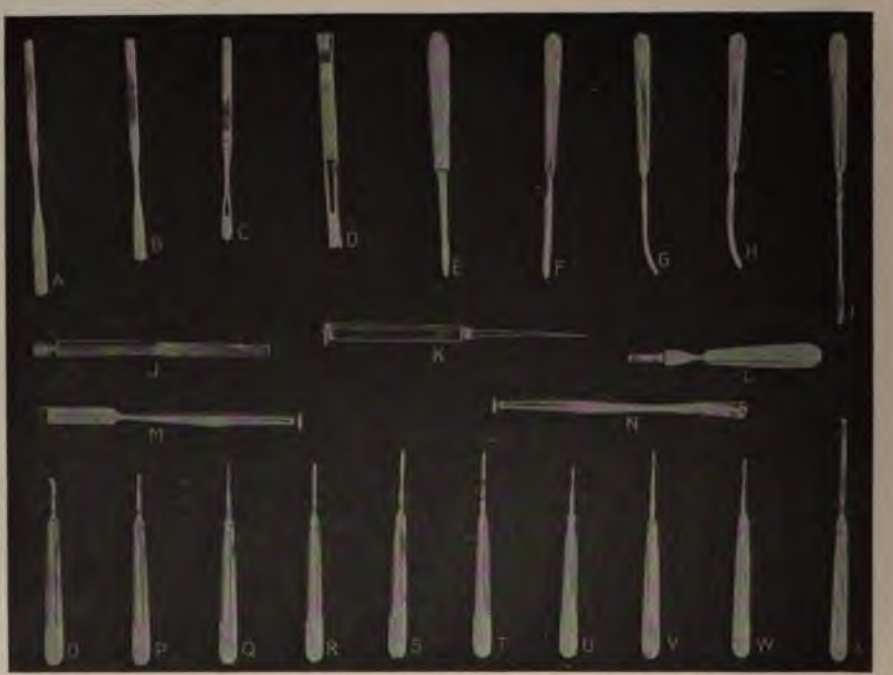

FIG. 161.—*A, B, C*, astragalectomy chisels; *D*, heavy bone gouge; *E, F*, blunt bone knives; *G, H*, blunt curved bistouries; *I*, long-shanked blunt tenotome; *J, K*, osteotomes or sharp bone knives; *L*, thumb gouge; *M*, chisel; *N*, gouge; *O* to *X*, tenotomes, with short and long cutting blades, and strong shanks of varying lengths, handles roughened on the back (see Fig. 584, p. 646).

Blunt, sharp and probe pointed tenotomes (Fig. 161, *O* to *X*): the cutting faces should vary from ½ to 1½ inches, and the shanks from 1 to 3 inches. The shanks should be double the usual strength found in the shops. Roughening on the back of the handle is essential in order that the cutting face can be located when it is buried in the tissues.

Osteotomes, wide and narrow: Osteotomes are bone knives without any shoulder as in a chisel. The ones with heavy handles are marked in inches (Fig. 161, *K–J*).

Mallets, wooden: Wooden mallets are better than metal ones (potato mashers will answer).

Tendon anastomosis forceps: in drawing tendons through a tunnel. Long curved forceps with teeth will facilitate (Fig. 162, *M*) (Reed).

Heavy clamp forceps for deep hemorrhage are very useful.

An S-shaped bone retractor helps greatly in protecting the muscles against the tip of a saw (Fig. 162, *I*).

Saws: Keyhole saws with long cutting face and the subcutaneous saw of Adams are occasionally needed (Fig. 162, *B*, *C*, *D*).

Gouges, wide and narrow and thumb gouges are convenient for bone work (Fig. 161, *N*, *L*).

Chisels (Fig. 161, *M*).

Foot wrenches (Fig. 162, *A*, and Fig. 620, p. 680) are frequently required.

Bending irons for braces are a necessity (Fig. 610, p. 673).

FIG. 162.—*A*, foot wrench (Jones); *B*, *C*, keyhole saws; *D*, Adams subcutaneous saw; *E*, *F*, bone forceps; *G*, *H*, retractors; *I*, curved bone retractor; *J*, claw bone-forceps; *K* and *L*, large long probes with handles, and with eye at tip; *M*, toothed long forceps for tendon transplantation; *N*, tracheotomy tube; *O*, toothed needle forceps; *P*, laminectomy forceps; *Q*, blunt dissector; *R*, periosteal elevator for cleft palate operation; *S*, lion-jaw forceps; *T*, heavy bone-forceps (Farnboeuf); *U*, rongeur forceps with flat lower blade; *V*, tunnelled flushing curette; *W*, bone-cutting forceps.

Probes, flexible and long, 12 to 18 inches, with handles, will be found serviceable for inserting through-and-through drainage as in psoas abscess (Fig. 162, *K*, *L*).

Curettes, heavy and light, are needed for removing both hard and soft tissues (Fig. 162, *V*).

Drills: An electric drill or a surgical engine is much superior to a hand drill unless the latter is short and readily controlled.

Osteoclasts: The Grattan, Rizzoli and Colin types are the best (Fig. 250, p. 300).

Two aspirators are required, as one frequently fails to work when most needed and it is advisable to have two thermocauteries for the same reason.

CHAPTER VIII.

FIXATION DRESSINGS AND SPLINTS.

PLASTER OF PARIS; GYPSUM.

Plaster of Paris lends itself so thoroughly to the uses of the surgeon that a few pages devoted to its manifold advantages seem advisable. When a surgeon has become thoroughly trained in its expert use he will find it one of his most efficient aids. Many surgeons condemn its employment simply because they are inexperienced and unskilled in its application and are unacquainted with its benefit and its adaptability to all sorts of cases. Judgment is necessary in its employment, as is the rule in all other matters. Plaster has the advantage of pressing equally upon many square inches of surface, while a wooden or metal splint bears most heavily upon one or two points. It is of especial value on account of its quick-setting properties, after operations, in fractures, in the correction of many deformities, in spinal disease, joint disease, sprains, in fact in any lesion where fixation is desirable. When a part is put absolutely at rest after a trauma or an operation, the perfect quiet insured by fixation gives almost entire freedom from pain and inflammatory sequences. A wound rarely becomes infected under a plaster cast even when it is soaked with blood and not removed for weeks, as after osteotomy. For children, relief of pain and the avoidance of frequent dressings is of inestimable value. As the maintenance of the desired corrected position is the important element in treatment after many operations, it is advisable for the surgeon himself to hold the limb while a skilled assistant applies the plaster. Some cases require much underpadding with cotton, others require little or none except the flannel bandage or stockinet tubular covering next the skin. The under bandage should make all the desired compression of the part, in order that the plaster bandage need only be rolled on loosely without any tension that after hardening will cause hard ridges. The danger urged against its use, namely, non-provision for swelling, is entirely obviated by the insertion, next to the stockinet, of a zinc strip upon which the thicker portion of the cast can be quickly divided with a knife when the plaster has PARTIALLY hardened (Fig. 163). The incision should be deepened until the metal can be distinguished at every part of its length, as any uncut bandage fibres delay subsequent spreading. This slit will save much time and labor in subsequent

FIG. 162.—Zinc strip, lower half shown wrapped in waxed paper.

removal and will also allow the cast to be spread open quickly in the night if pressure symptoms develop. A slight bridge left uncut at the top and bottom of the cast (Fig. 166) will hold it in place until it has thoroughly set and the patient has recovered from the ether. The metal strip can be more easily removed if wrapped in waxed paper. With this splitting of the cast, plaster can be safely applied in fractures and other traumatisms IMMEDIATELY after the injury.

PREPARATION OF BANDAGES.—Fine ground, dry, Nova Scotia plaster is best. First quality of plaster for dentists sets too quickly for surgical use. For children's work, narrow bandages of crinoline one and one and a half inches wide should be prepared for feet and hands; wider ones, three to four inches, for the trunk and four to five yards long. A bandage machine is useful, but machine-rolled plaster bandages are seldom as satisfactory as those made by hand. Hand-made bandages are prepared on a dry day on a long table covered with mackintosh. From a pile of loose plaster a thick coating of plaster is spread with spatula or table knife over the strip of crinoline, which is loosely rolled with the left hand as the spreading progresses. The layer of plaster is usually applied too thin, and if the bandage is too tightly rolled, water will not readily penetrate it. Wrapped in waxed paper they are stored in tin cans. In hospitals even bandages taken from the same receptacle will vary greatly in their setting qualities, possibly having been made at different times. It frequently happens that the cast on one leg will harden quickly while the other will remain soft for hours. Wide open-mesh crinoline should be used; it must contain starch only, not glue, but it is difficult to obtain[1] and washing takes out both glue and starch. Cheese-cloth is not good, nor ordinary surgical gauze. Commercial plaster bandages in sealed individual tin cans can now be obtained so readily from any drug store that they are available to every surgeon and practitioner and are more convenient when but few are needed. Wet plaster bandages when applied should feel oily; if gritty, they will rarely set well. If made up in damp weather, they are apt to be poor. If kept in a tight tin can in a dry place, the author has found them in excellent condition, if reheated, after having been laid aside for two years. Neither salt nor alum nor borax nor potassium sulphate is needed to induce setting if the bandage is properly made; water of the temperature of the room is sufficient. A half dozen bandages dumped in a shallow basin of water will never be satisfactory, as air cannot escape thoroughly while they are on their sides. The water in the pail should be an inch deeper than the widest

FIG. 164.—Long spica plaster cast as applied after osteotomy of femur for flexion ankylosis, or for fractures. Cast can be split on metal strip while partially hardened, as seen in Fig. 166.

[1] Claflin now sells a crinoline without glue.

bandage to be used. A good nurse will insert in definite sequence one bandage at a time UPON ITS END in the water and allow it to remain until ALL BUBBLING OF AIR has ceased, timing her insertions to the rapidity of application. She will not remove the bandages from the water until a signal from the surgeon shows that he is ready for the next. With hands on both ends to prevent the escape of plaster, she will then express the water moderately from the interstices, being careful that the bandage is not deformed in so doing. Waste of plaster is prevented if the bandages are wrapped in Japanese paper napkins. She will wipe from the ends the superficial dripping water, loosen a half inch of the end, and present it to the surgeon ready for quick use. The surgeon should weld together each of the turns of the bandage by rubbing them in a circular manner and when completed should rub thoroughly with a wet hand or with cotton ball, polishing the surface finally with a strip of dry muslin bandage drawn to and fro in a rapid manner. The surgeon should use care that the cast is of even thickness throughout, as a single weak circle ruins the whole. In fractures or osteotomies, the assistant should first encircle the FRACTURED region with the plaster bandage while the best control and adaptation of the limb is secured by the surgeon himself; less important areas of the limb are to be dressed last. Great care must be taken not to make indentations with fingers, or wrinkles, as every pressure makes a bulge upon the inner surface which, when hardened, becomes a cause of pain or of sloughing. In the feet, corns and callosities should be removed previously, as they become very painful under the pressure of a cast. Tubular seamless stockinet of various diameters is better than undervests or stockings or flannel bandages to protect the skin. Cotton should be placed over all bony prominences before the plaster is applied; the anterior superior spines, the malleoli and the heel requiring special protection. Piano felt, stitched to the stockinet over a kyphosis, is excellent. Three thicknesses of bandage are often sufficient and few casts in children need to be more than one-eighth to one-sixteenth of an inch in thickness, if sufficient time is given for setting. When of proper thickness the X-ray readily penetrates them (Fig. 165).

FIG. 165. — X-ray skiagram taken through a plaster cast applied for injury of the wrist.

The cast may be rendered more durable by painting it over with a solution of sodium silicate, or may be rendered less absorbent to urine and other discharges by painting with shellac. Mixing Portland cement 5 per cent. with the plaster renders the cast more rigid. Dry plaster or plaster cream rubbed over the surface is liable to crumble off in the bed and be-

come very uncomfortable. For strengthening the cast in regions like the groin, numerous longitudinal reverses and loose wrinklings of the bandage should be made. The insertion of tin strips also saves weight, especially in spicas (Fig. 166) and trunk bandages (Fig. 167).

FIG. 166.—Long spica of hip applied with body supported on pelvic dressing stool (page 494) and with rubber pillow under thorax. These supports prevent movement of the hip and secure a straight position during application and until the plaster has thoroughly hardened.

A lighter cast may be made by inserting in the proportion of 1: 5, a mixture of gum arabic 10: starch 20: white chalk 27: alum sulphate 60 (Vogel).

REMOVAL OF CAST.—An old hardened cast that has not been slit as described above can be removed with saw and plaster cutters, but is a hard task for the surgeon in hot weather (Fig. 168, B, C, J, K). Fig. 168, L, is an excellent pattern of cloth-cutter's knife; it is thin, has a strong handle in which the point can be buried for carrying, since it has no hinge for closing as an ordinary knife. The line of incision in the cast may be softened with water, vinegar, acetic or hydrochloric acid, or hydrogen peroxide. When the stockinet is reached, as is indicated both by sound and feeling, the gap may be widened with plaster claws (Fig. 168 H, I) or by prying instrument, the underlying bandage cut with ordinary bandage scissors, and the cast sprung open. If the cast is reapplied, the hard sharp edges should be rounded. If there has been shrinkage of the limb, a longitudinal section of the cast should be removed from one edge, after which it can be fitted more closely by an enveloping bandage, thus avoiding any danger of insufficient support. Strong shears and saws of various shapes (Fig. 168 J and B) are often required and when the cast is not to be saved a metal hack-saw cuts rapidly. The edges of a plaster cast may be covered by turning over the stockinet or undervest inside lining. For a removable cast the edges after cutting may be bordered with adhesive plaster or a leather facing with eyelets or lace hooks may be added. A leg cast, that does not include the foot, may be prevented from slipping by incorporating, during its application, a strip of adhesive plaster applied to the anterior part of the leg and turned up at the bottom. A child can be made more

FIG. 167.—Plaster jacket divided in front while partially hardened.

comfortable by inserting, next the skin, a longitudinal muslin bandage which remains permanently and can be used, with a to-and-fro motion, to relieve itching and secure cleanliness. Powder, also, or ointment can be thus carried beneath the cast. A long and a short cast are shown in Figs. 169 and 170.

Magnesite Splints.—Crinoline bandages soaked in a strong solution of magnesium oxychloride[1] are applied in the same manner as plaster bandages; are said to set more rapidly, to form a lighter and thinner cast and

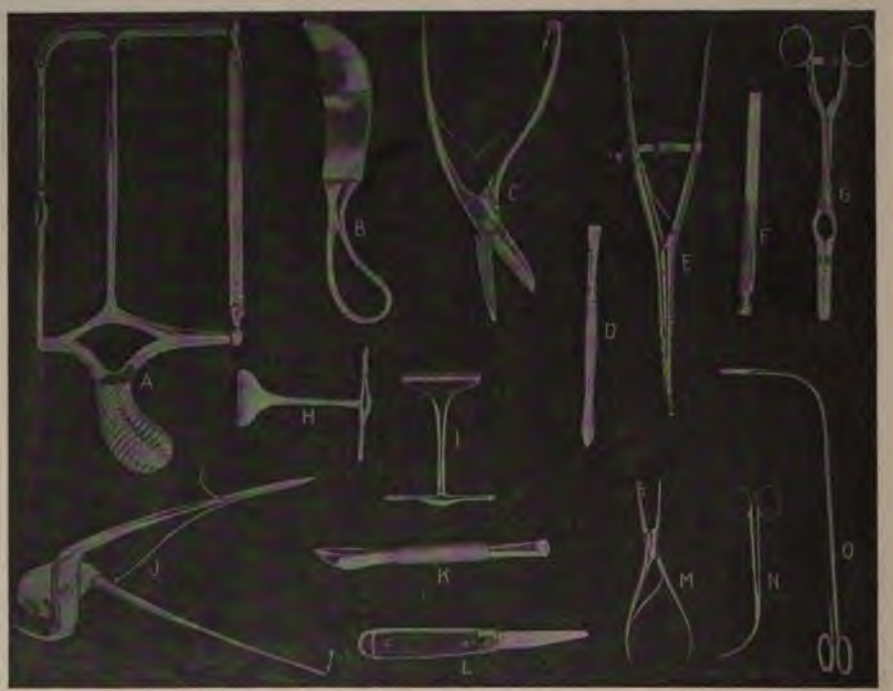

FIG. 168.—*A*, butcher's saw; *B*, plaster saw; *C*, plaster shears; *D*, elevator; *E*, dilators; *F*, narrow osteotome; *G*, clamps; *H* and *I*, plaster claws; *J*, Reed's plaster shears; *K*, plaster knife and separator; *L*, sharp plaster knife; *M*, nasal punch; *N*, tracheotomy forceps; *O*, esophageal forceps.

are of especial benefit from the fact that the cast possesses four to six times the penetrability to the X-rays. Dry heat hardens the setting and a cast for foot and leg will weigh but one pound.

Silicate of Soda.—Liquid glass applied with brush over successive layers of muslin bandage is used extensively and makes a light, neat fixed dressing, but it is very slow in drying, and is not available when corrective quick fixation is desired as in fracture, club-foot, knock-knee, osteotomies, spine disease, etc.

Starch Bandages.—A cheap rigid dressing may be made by applying to a limb muslin bandages soaked in ordinary laundry boiled starch. Setting is slow.

DEXTRIN, PARAFFIN, GLUE and other substances also are employed.

[1] Jour. Amer. Med. Assoc., Feb. 22, 1908, 580.

Leather.—Sole leather, raw, partially tanned or tanned by the old oak-bark process, is now difficult to obtain. Ordinary sole leather and rawhide are not nearly as advantageous as the older preparation. Leather splints are excellent and serviceable. They are made by first taking a cast of any desired region of the body with plaster bandages, opening it with bandage shears as soon as hardened and making a counter-cast mold. Well-soaked leather is bound tightly upon the mold for several weeks until slowly dried, after which it is baked, fitted, perforated, trimmed and prepared with eyelets or hooks for lacing (Fig. 219, p. 279). These leather supports make exceedingly useful and comfortable appliances for spine or for joints.

FIG. 169.—Long and short plaster casts applied for disease of knee and ankle. To fix a knee the cast should extend up to the perineum.

Celluloid.—Celluloid is light and makes an excellent splint. Thin strips of celluloid may be softened in hot water and applied over a plaster mold of any region of the body, or celluloid or pyroline may be dissolved in acetone to give a consistency of thick syrup[1] and kept in a closed jar. Between each of five or six layers of stockinet applied over a plaster mold, a layer of several coats of this liquid is brushed. At the end of a week, the cast is slit open and coated on the inside with another layer of the celluloid. Lacing eyelets or hooks, or buckles are added. This thick paste is applied over a plaster counter-cast covered with stockinet. Several coats are applied and the material allowed to dry. Sufficient layers of cheese-cloth or stockinet or cloth to make a firm cast are successively applied, coated with the paste and dried so thoroughly that the jacket will not warp when removed from the cast. Such a splint when trimmed and perforated is light and convenient.

FIG. 170.—Improperly applied cast for knee disease, as the joint is imperfectly supported above for only a few inches of the thigh, while below even the ankle is included.

For limbs, sheet celluloid or pyroline may be softened in hot water and bound upon a counter-cast with elastic tubing until thoroughly hardened. If the cast and celluloid are immersed in boiling water the fitting will be made accurate.

Felt Splints.—Felt cloth of desired thickness, soaked in a saturated solution of shellac and alcohol and applied over a plaster mold, is still further strengthened by coatings of shellac until it will no longer absorb. When hardened, it is finished with lacing hooks and strengthened with steel strips. RUSSIAN FELT, saturated with sizing, may be fitted to a mold by dry heat.

[1] Young, Orthopaedic Surgery, 159.

-Layers of paper united with glue, applied over a plaster mold
ly dried, make a light splint.
-Thin sheets of wood of the thickness of paper are applied
r mold, the layers being alternated with stockinet, bandage,
n.
m.—Aluminum is light and firm, and if the splint is made in
ith hinge is available even for body corsets. As it must be
shape as in repoussé brass work, the counter-cast must be
with cement or oakum.
Counter-casts.—Casts of any region of the body can be made
laster cream. The skin is covered with cosmoline or talcum
the plaster applied to one-half of the member. The upper
oothed and coated with cosmoline, after which the remaining
d with the plaster cream in the same way. The two sections
coated on the inner side with cosmoline or soapsuds, bandaged
the interior filled with fresh plaster cream, which when
ll give a very exact representation of the region. A tough
model which can be sawed is made by mixing 10 per cent. of
root with the plaster and dipping the cast in boiling alum

CHAPTER IX.

ROTARY LATERAL CURVATURE OF THE SPINE.

Synonyms: Scoliosis; Seitliche Verbiegung.

ROTARY LATERAL CURVATURE of the spine is a deviation of the spinal column from the normal median line, which deviation has become more or less fixed and is accompanied by a rotation of the vertebral bodies (Fig. 171). Momentary physiological lateral curvature occurs each time that the body weight is borne unequally upon the lower limbs in the adjustment of equilibrium.

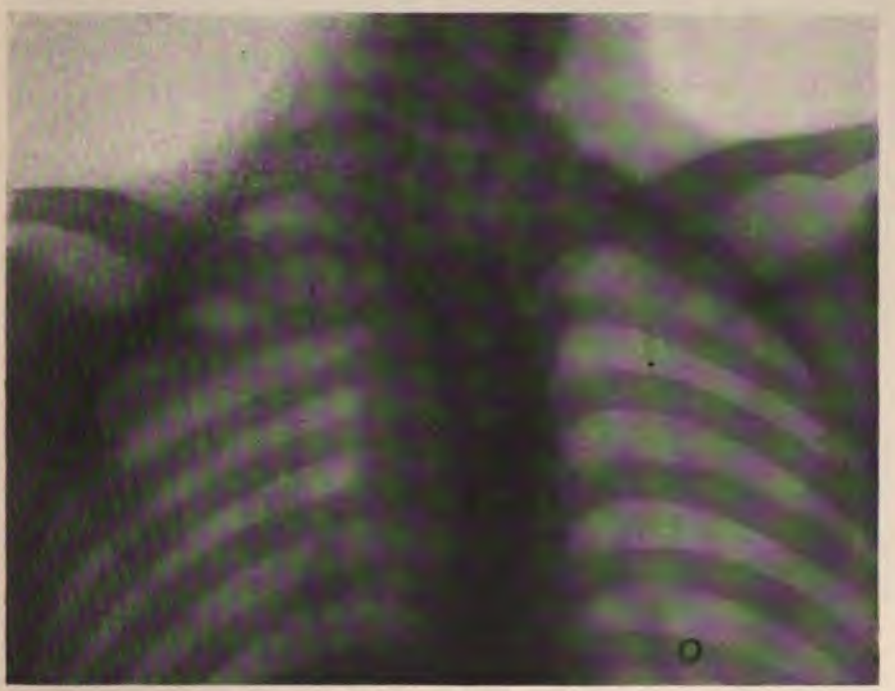

FIG. 171.—Rotation of vertebral bodies with high lateral curvature and wryneck.

Lateral curvature is not a bone disease but is a bone distortion combined with a muscle debility and ligamentous change which is followed by a wedge-shaped condition of the intervertebral cartilages and twisting of vertebræ themselves (Fig. 172).

Causes.—Many theories more or less ingenious have been advanced, the fact being that the causes are multitudinous.[1] They may be classed

[1] Amer. Jour. Orth. Surg., Aug., 1908, 199.

as developmental, mechanical, pathological, static, functional and postural. Asymmetry and nutritional changes at puberty also produce bone and muscle alterations[1] (Fig. 172).

Another classification[2] is organic; primary, congenital, rhachitic, osteomalacic and pubescent. Secondary, from empyema, infantile paralysis or tumors.

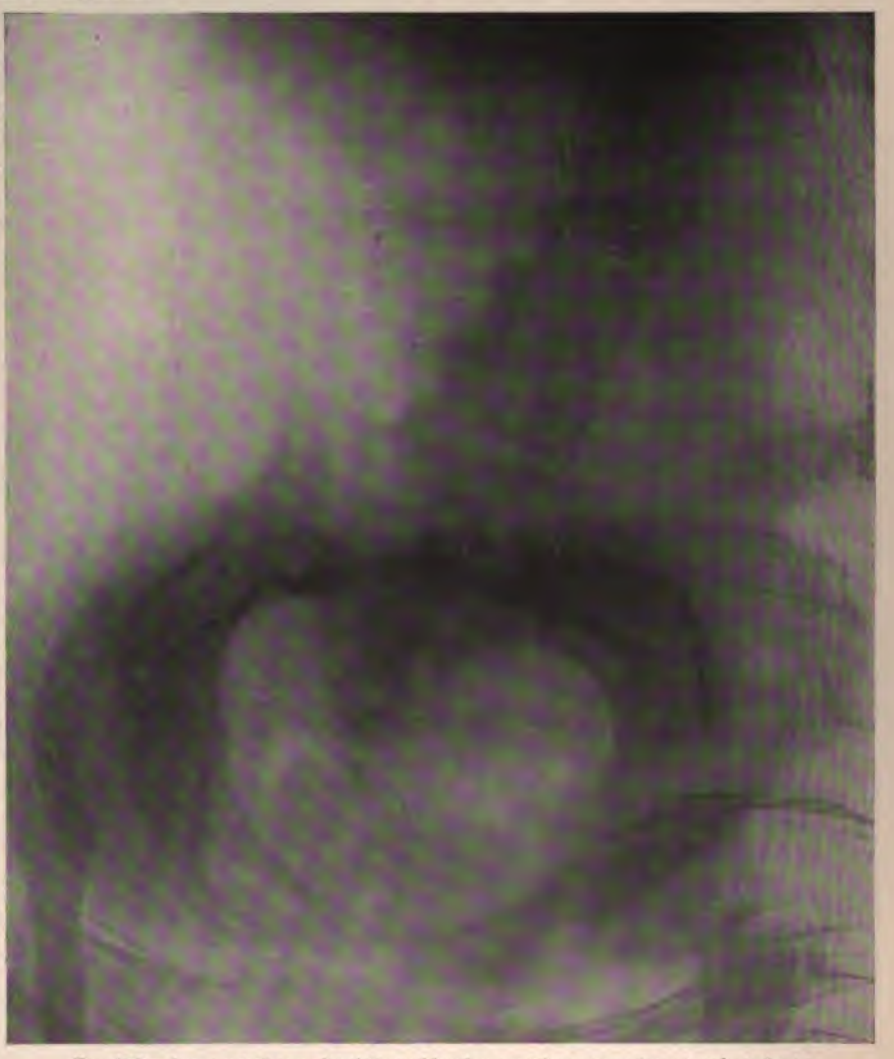

FIG. 172.—Large rotation and twisting of lumbar vertebræ, occurring at early puberty.

Faulty positions of standing and sitting, occupation, weight-bearing, asymmetry of development in pelvis, head, legs, arms or body, weakened muscles, rickets, loss of arm, hip disease (Fig. 173), short leg, empyema,

[1] Kong. d. Italienischen Orth., Bologna, 1907; Zeitsch. f. Schulgesundheitsphlege, Aug. 9, 1906; Zeitsch. f. Orth. Surg., xix, 286; Nathan, Amer. Jour. Orth. Surg., 1909, vi, 379.

[2] Feiss, Amer. Jour. Orth. Surg., Jan., 1908, and Feb., 1909, 390, 391.

muscle atrophy, paralysis (Fig. 174), torticollis from eyestrain, etc.; all will be found as factors in producing this condition.[1] Lateral curvature is readily produced in feeble infants by false methods of holding and carrying and by rickets and infantile paralysis.

Congenital Scoliosis.—The congenital form is usually due to malformation of vertebræ [2] or ribs, to absence or surplus of segments, or fusion of vertebræ on one side, caused by faults of development in embryonic life and tending to distort the spine (Fig. 175). In the cervical region a supernumerary vertebra or an eighth cervical rib may distort. An additional sixth lumbar or first sacral will necessarily alter the symmetry of the superimposed structure.[3] In many cases the cause is obscure (McKenzie).

FIG. 173.—Lateral curvature as the result of old tuberculous hip disease.

Rotation. — Persistent postural conditions, as well as other causes, may produce a permanent condition of curvature with rotation, yet many cases of inequality of legs from paralysis or other cause continue through life with no such deformity. A

FIG. 174.—Lateral curvature resulting from severe infantile spinal paralysis. Note dissimilarity of development of pelvis and legs compared with shoulders and arms.

simple test for asymmetry of legs is made by wooden blocks one-fourth, one-half, three-fourths and one inch in thickness, to be used for blocking up the short leg. A more convenient appliance is a specially constructed box on which the patient stands, one-half of which is a movable platform raised by a ratchet to the amount of correction as shown in Fig. 176.

[1] Cotton, Boston School Commission, Amer. Phys. Education Review, Dec., 1904.

[2] Bradford, Amer. Jour. Orth. Surg., Aug., 1908; Mass. Gen. Hosp. Report., June, 1907, 123; Bos. Med. and Surg. Jour., cliv, 1906, 99 and 624, and clv, 21, 598, 611; Amer. Jour. Orth. Surg., Nov., 1909, 278.

[3] Breuss and Kalisco, Handbuch d. Orth. Chir., 3, 681.

This can be arranged to show the inches and fractions upon a scale. Inequality in the length of the legs may equal an inch in apparently normal individuals. ORGANIC or TRUE LATERAL CURVATURE persists in spite of change of position. It is practically always accompanied by more or less rotation of the bodies of the vertebræ (Fig. 177). The spine being a flexible column follows the law of any flexible rod, which bent laterally also rotates on its own axis. Rotation is probably due largely to the fact that the BODIES of the vertebræ are free to swing in the abdomen and chest while the posterior vertebral segments are held more rigidly in position, first by the uneven conformations of the articular processes and secondly by ligaments and spinal muscles. Various explanations

FIG. 175.—Congenital defects and extra cervical rib causing lateral curvature and wryneck. Note the uneven course of ribs on the opposite sides.

have been made and numerous experiments conducted[1] to demonstrate this fact. With this bending and rotation of the vertebræ must necessarily result the backward projection and angulation of the ribs on the one side (Fig. 178) with forward inclination and flattening of the other side and compensatory changes of chest anteriorly. In later life, great bony changes may seriously interfere with oxygenation of the blood, and pressure of the distorted ribs upon the crests of the ilium will give great pain and permanent disability. In rhachitic cases the deformity of the pelvis may prove serious in girls in later life.

Frequency.—Scoliosis of slight degree may be found in a large proportion of children, varying from 25 to 30 per cent. Statistics in regard to the existence of this deformity in the different sexes vary greatly.[2] Exami-

[1] Judson, Trans. Amer. Orth. Assoc., 1901.

[2] Lovett, Lat. Curv. of the Spine and Round Shoulders, Octavo, pp. 188, 1907; and Jour. Amer. Med. Assoc., June 23, 1906.

FIG. 176.—Movable platform box upon which patient stands to measure inequality in length of lower limbs. (Young.)

FIG. 177.— Lateral curvature with rotation of bodies of the vertebræ to the right in lumbar region, to the left in lower dorsal, to the right in upper dorsal. (Mütter Museum, Philada. Coll. of Phys.)

nations of patients applying at orthopaedic clinics give a great preponderance in favor of girls, while the examination of school children shows that boys are as frequently affected. The fact that girls are more likely to apply for treatment explains this difference.

Age.—Lateral curvature may appear early in rickety infants from faulty positions of holding or carrying. The rapidly growing period from eight to fifteen gives the greatest number of cases in both boys and girls. While the nutritional changes occurring at puberty are more serious in girls than in boys, late rickets may occur in either sex.[1]

Examination.—In the early stage the faulty attitude is usually discovered by the dressmaker or mother, who finds that the skirts upon one side are shorter than the other, or that the shoulders vary in height, or that one shoulder-blade is more prominent than the other. In all children, examinations must be made with the patient naked, in order that any deviation from normal in trunk, neck, arms, legs and feet can be properly noted. In older children the shoulders and back, sides and buttocks must be thoroughly exposed. The orthopaedic surgeon should have in his office a variety of loose gowns opening to the floor in the back and separate skirts with ELASTIC top bands for girls. When such an examining outfit is not at hand, a sheet or short skirt may be pinned loosely about the hips just above the trochanters and a towel or napkin fastened about the neck to cover the mammæ. It is impossible to accurately decide in regard to a slight lateral curvature unless such exposure of the body is secured.

FIG. 178.—Scoliosis, with projection of ribs on left side and flattening of chest on right side from rotation of dorsal vertebræ. Right lumbar rotation slight.

The tips of the spinous processes, both in erect and bent positions, are to be marked with colored skin pencil or ink, also the vertebra prominens, the inferior and posterior superior angles of the scapulæ and their angle of rotation, the acromion, the posterior border of the axilla, the axis of the pelvis and the posterior superior spines of the iliac bones. The direction of the cleft of the nates will show the axis of the pelvis and lead to an examination as to the length of the legs and of deformities of the lower limbs and feet. The patient must stand in a good light directly in front of the surgeon. The difference in the height of the shoulders, the posterior projection and height of the scapulæ and ribs, the rotation of the scapulæ, the relation of the arms to the sides, the altered height of the hips and the various positions of body should be carefully noted. One waist-line will be deeper and higher; one hip much more prominent than the other (Fig. 179). The spinous processes of the vertebræ will show a marked curvature to right or left in cervical, dorsal or lumbar regions. These curves may either be SINGLE, DOUBLE (Fig. 179), COMPOUND (Fig.

[1] Med. du Nord, Lille, 1907, xl, 557.

FIG. 179.—Double scoliosis. Note the relation of the arms to the body, the differing heights of the waist-lines, the uneven projection of the hips, the prominence of the left thorax and scapula.

FIG. 180.—Compound lateral curvature with rotation and elevation in right dorsal and left lumbar regions.

180), or COMPENSATORY. A plummet line dropped from one acromion will fall far outside the trochanter, while a similar line on the other side will strike the buttock near the internatal crease if the deformity is great. One

FIG. 181.—Extreme rotation of vertebræ. A fall in infancy probably produced either a fracture or dislocation at the first dorsal. Note the differing course of each rib on the opposite sides, and the marked displacement at the junction of the neck with the chest.

arm will fall outside the trochanter while the other will fall within it (Fig. 179). Suspension by the head will straighten the curves unless they are old and fixed. Lateral and backward flexibility should both be tested. In severe cases the amount of rotation may be tested by X-ray (Fig. 181).

Anterior View.—The following points should be noted: The relative height of the shoulders and nipples; the contour of the two sides from the shoulders to the hips; the direction of the median line of the body; the direction of the vulvar fissure; the position of the body in standing upon one and on both legs; the position of the arms and hips; the point at which a plummet line dropped from the anterior axillary border falls across the trochanter or the groin; the position of the head and of the neck and the deformation of the thorax.

Curves.—Curves are spoken of as PRIMARY and SECONDARY, the latter being compensatory. It is difficult, however, unless the case is seen early, to decide which is the primary deviation. A right curve is one with the

FIG. 182.—Marked rotation of lumbar vertebræ to the left—right thoracic rotation moderate.

FIG. 183.—Slight scoliosis almost entirely corrected by voluntary muscular action, after several months of gymnastic exercises (see Fig. 217).

primary convexity to the right of the median line; the left, the opposite. Roth in one thousand cases gives the whole convexity to the left in 52 per cent. of the cases; whole convexity to the right, 7 per cent.; dorsal to right and lumbar to left, 33 per cent.; dorsal to left and lumbar to right, 4.5 per cent. Rotation of the trunk to the right or left will bring out the erector spinæ group prominently and diminish the rotation. In the stooping posture with body at right angles to the femurs, any prominence of the thorax or in the lumbar region will indicate the amount of rotation (Fig. 182). The arms and side lines of the body in a bad lateral curvature will show unequal triangular spaces upon the different sides (Fig. 179). After the examination in the erect and flexed positions, a test can then be made as to the BEST VOLUNTARY attainable position (Fig. 183). The case should be examined first with both arms elevated alongside the head, keynote **U** (Fig. 184); then with the arm on the concave side alongside the head,

the other at right angles to the body, keynote L (Fig. 185); then in the reversed position, keynote ⅃ (Fig. 186).

The view from the side in severe cases will readily demonstrate flattening of thorax on one side with marked projection of ribs and scapulæ on the other, giving the appearance at first glance of a kyphosis and in late cases, when accompanied by rigidity, may be mistaken for a spinal caries (Fig. 187).

FIG. 184.—Arms alongside of head in U position, hanging from double trapeze. Right thoracic and left lumbar projection.

A note should always be made as to whether the child was nursed or bottle fed, the diseases with which the child was affected, the primary results that have followed and the general state of nutrition during life. Evidences of rickets should be sought. When exercises are to be employed, the condition of the

FIG. 185.—Arms in keynote L position. Note inequality of hips and waist-line. Line of internatal fissure crosses to right of vertebra prominens.

heart and lungs should be examined. The comparative length of the legs, existence of knock-knee, flat-foot, paralysis, etc., should be noted. A plummet line dropped from the vertebra prominens should pass through the internatal cleft and the normal spinous processes should lie beneath this line (Fig. 186). Any deviation to right or left is thus readily noticed. The projection of the thorax may commence at the upper ribs and extend throughout that region, or it may be in either upper or lower part of the chest. It should be noted that the lumbar projection will be less marked than that of the thoracic portion (Fig. 178, p. 256).

Diagnosis.—The principal condition likely to be confounded with lateral curvature is an atypical SPINAL CARIES WITH LATERAL TILT (Fig. 351, p. 412), caused by the yielding of the carious vertebræ and articular processes more upon one side than upon the other. It will be noted that in caries there is a lateral tilt, not a lateral curvature, but only a sharp angular bending to one side. The rigidity of the spine, the reflex pains, the difficulty in bending and stooping will all be present in caries. The history and a careful examination of a case of scoliosis may show the coexistence of torticollis or rickets or distorted pelvis or paralysis or disease of the joints. Later, in spinal caries, the sharp kyphosis and increasing rigidity will make the condition plain. The posterior projection and rigidity of a confirmed lateral curvature should not be mistaken for bone disease. The treatment for lateral curvature and for spinal caries is so distinctly opposite that no doubtful case should receive gymnastic exercises until the diagnosis is thoroughly established.

FIG. 186.—Arms in reversed keynote J position.

FIG. 187.—Viewed through the clothing this case might be mistaken for one of spinal caries kyphosis. The posterior projection is caused by the angulation of the ribs on the right side while the left thorax is flattened and scapula rotated. The spinous processes follow the shadow in the furrow.

Pleuritic and empyemic cases are frequently mistaken for scoliosis (Fig. 188). The X-ray and a thorough physical examination will establish the diagnosis (p. 93).

Scoliosometers — Scoliosometry — Scoliosis Recording.—The simplest and most convenient method of recording is the plan described by Elmer.[1] A strip of adhesive plaster three inches wide is laid along the spine from the

[1] Elmer, Arch. Pediatrics, Feb., 1909, 97, and vi, 391.

FIG. 188.—Lateral curvature following empyema with depression of left thorax, and partial collapse of lung. Note tilt of body to the right, arms are in keynote L position.

FIG. 189. — Adhesive plaster strip temporarily applied to back, and line of spinous processes traced upon it in pencil.

FIG. 190. — Record of six strips of adhesive plaster, showing progressive improvement of line of spinous processes under gymnastic treatment. Read from left to right.

vertebra prominens to the sacrum. The spinous processes are marked and outlined (Fig. 189). The plaster is then removed, backed with brown paper, labelled with name and date and filed for future comparison (Fig. 190). Tracings and outlining with tin or lead strips, plaster molds and the X-ray have all been employed to record the condition. A glass plate or transparent celluloid tracing transferred to paper is also useful. Tracings of the trunk at various regions [1] by strips of dental wax and by a rod with

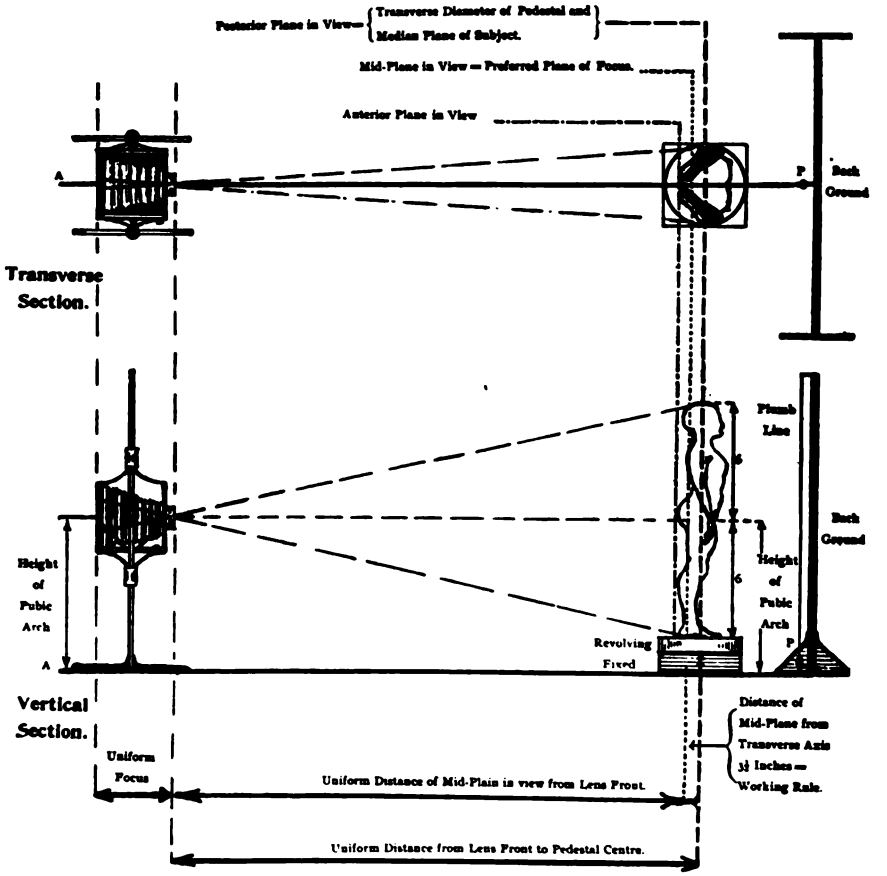

FIG. 191.—Photography by exact position of patient and of camera, securing accurate results at different periods of treatment. (Spellissy.)

rotating index to record vertical rotation have been tried. PHOTOGRAPHY by the surgeon under definite conditions with a graduated net-work screen (Fig. 185) is excellent, but it is liable to many errors. The exact methods of distance, position of patient and of camera and the revolving stand advocated by Spellissy yield very accurate results but the methods are too complicated for other than an expert (Fig. 191).

[1] Bradford, Amer. Jour. Orth. Surg., Apr., 1908, 436.

Multitudes of SCOLIOSOMETERS have been manufactured; some good, some useless, all requiring time for their employment and all subject to errors. These errors are non-preventable, as will be noted by any one who carefully examines the constantly changing conditions in the bared back of an individual under different postures. The helpful but complicated apparatus of Hudson, Ellington,[1] (Fig. 192), Schulthess, Zander, Feiss, Beely, Young (Fig. 193), Dufestel[2] and others have each their advocates.[3] Young has discovered no less than 68 devices[4] for recording these deviations.

FIG. 192.—Movable rods for recording scoliosis and kyphosis.

Treatment.—(I) Removal of causes; (II) prevention and general simple measures; (III) correction by voluntary and involuntary gymnastic exercises; (IV) increase of backward and lateral flexibility; (V) correction by plaster jackets, applied progressively in improved positions and removable for gymnastic exercises; (VI) leather jackets applied over a plaster mold corrected to the normal body;

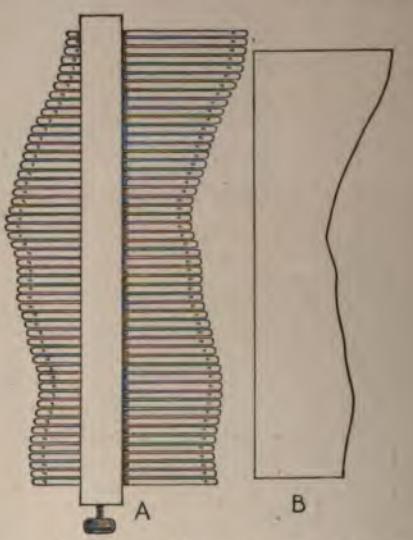

FIG. 193.—*A*, movable wooden rods for registering deformities of spine and of thorax; *B*, the record. (Young.)

(VII) forcible correction by mechanical and hand pressure; (VIII) steel corsets; (IX) operative treatment.

I. REMOVAL OF CAUSES.—In order to prevent and correct the initial stage of scoliosis, it is important that the tendency is diagnosed before deformity and rotation have taken place.

All discoverable causes should be removed. Short leg, flat-foot and in-knee should be corrected, occupational causes relieved, bad habits of

[1] International Clinics, vol. iv, Series 18, 1908.
[2] La Medic. Scolaire, Feb., 1908.
[3] Lovett, Lat. Curv., 1907, Octavo, 73.
[4] Young, Orth. Surg., 2d ed., 563; Hovorka, Mitth. d. Anthropol. Gesell., Wien, 1904, xxxiv.

sitting, studying, standing and lying abandoned (Figs. 194, 196). Constitutional and hygienic conditions must be improved. Mental advancement must be subordinated to the physical, and school life temporarily suspended.

FIG. 194.—Faulty position in writing and studying.

FIG. 195.—Straight position in studying at table.

FIG. 196.—Faulty position of sitting, tending to deformities.

FIG. 197.—Correct position of sitting with body erect, feet touching floor—pelvis supported by back of chair.

The disturbances of puberty are to be regulated and an out-door life followed. Side-saddle riding is injurious but riding astride is a healthful exercise.

II. Prevention and Simple Measures.—The dorsal position without pillow is best at night. A pad or cradle may be placed under the convex side. When tired, rest should be secured by lying on a hard flat couch, not by sitting. If the child reads while lying down, the prone position is best. In sitting, the chair seat may be slanted and a sloping seat bicycle used (Fig. 198). An erect carriage of body may be secured by walking with light weight upon the head. A short leg should be lengthened by cork sole, or by heel raised with rubber (Fig. 199).

If family physicians would frequently examine young children naked, many cases of lateral curvature could be prevented by early treatment.

Fig. 198.—Bicycle with sloping seat and sloping handles for lateral curvature.

Fig. 199.—Corrugated rubber heel to be worn inside of shoe. (Reiszner.)

School habits and school desks should be made to prevent rather than cure curvature. In regard to the effect of muscular action, every student of anatomy knows how complex is the system of muscles attached to the spine. This probably explains the difference of opinion that exists even among experts as to the movements best calculated to correct a lateral curvature. In an infant, of course, voluntary exercises are impossible; if the child has been carried steadily in one position, it should be shifted to the other arm and repeated forcible straightening of the spine and massage with olive oil employed to secure a better muscular tone. Such an infant should not be allowed to sit up, but should lie upon its back with pressure from a firm pillow beneath the projecting ribs. When the child is not controlled by the mother a plaster jacket should be applied, which can be taken

off twice a day for forcible straightening and massage; or the child may be put in bed with head and foot extension and have massage.[1]

General Rules.—(1) Hold chin *in*, chest *out*, and abdomen *in*. (2) Never cross the arms. (3) Do not sleep with arms above the head. (4) Do not use the arms in rising from chair or bench; make the thighs do this work. (5) Stand with weight equally on both feet. (6) Never sit on front edge of chair and lean against the back. Rest feet on floor. (7) Sleep flat on the back. A small roll may be placed under the neck. Sleeping on abdomen is permissible.

III. Correction by Voluntary and Involuntary Gymnastic Exercises.—The object of gymnastic exercises is to bring into play the voluntary action of the individual,[2] to strengthen the weakened muscles upon the convex side and stretch contracted ones, to increase the flexibility of the spine and trunk laterally and backward, to improve the general health and to correct all causes, unhygienic, mechanical or occupational. The army "setting up" drill is excellent. Whether employed alone or in conjunction with other measures these movements must be closely supervised and regulated by the surgeon or by a well-trained assistant who will persistently and continuously watch every detail. A capable instructor is one who is enthusiastic, progressive, tactful with children, who will give as close attention to the last treatment as to the first one and will see that every deviation from the prescribed movements is corrected.[3] It is very seldom that such exercises will be carried out at home. Wealthy mothers will not watch over them and poor mothers cannot, since so much time and care are required. No more discouraging case is encountered than lateral curvature in a girl obliged to earn her own living. After a child, however, has been thoroughly instructed in an orthopaedic gymnasium, a series of simple exercises may be planned in some cases and successfully carried out at home, though with less benefit. An important element in the treatment is the coöperation of the patient. The pride of the girl must be stimulated and she must be made to feel that she and she alone is largely responsible for her future development; that neglect or carelessness or inattention on her part will result in a deformity that will be life long; but that with thorough work in the early stage, great benefit will result.

The majority of orthopaedic surgeons in the United States, and Schulthess,[4] Lange, Klapp,[5] Chlumsky,[6] Rizzoli, Roth,[7] Fischer and others in Europe, have faith in gymnastic muscular development, provided it is wisely supervised and directed by the surgeon or by a trained and skilled instructor. Schulthess' apparatus is rather complicated. Lange's active

[1] Willard, Treatment Lateral Curvature, Therapeutic Gaz., xxv, 372; Amer. Lancet, 1893, 209.

[2] Taylor, Internat. Clinics, iv, 2d Series.

[3] Lovett, Bos. Med. and Surg. Jour., June 14, 1900; Oct. 31, 1901; Aug. 6, 1903; March 17, 1904; Sept. 28, 1905; Amer. Jour. Anat., Oct. 1, 1903; Bos. Soc. Physical Education, May 17, 1906.

[4] Schulthess, Joachimstal's Handbuch d. Orth. Chirurg.

[5] Bradford and Soutter, Amer. Jour. Orth. Surg., Aug., 1908, 99, and 1909, vi, 99; Zeitschrift f. Orth. Chir., Band. xx; Trans. Congress d. Deut. Gesell. f. Orth. Chir., vii, 1908; Deut. Militararztl., Jan. 20, 1908; Deut. med. Woch., 52, 2181.

[6] Lovett, Amer. Jour. Orth. Surg., Feb., 1909, 510.

[7] Roth, 1000 cases, Brit. Med. Jour., Oct. 9, 1897.

ercises do not require so many appliances, while Klapp
on FLOOR CREEPING EXERCISES with the spine horizontal.
thor's Orthopaedic Gymnasium at the University Hospital
r School for Crippled Children, voluntary muscular postures
mewhat as follows, each individual being carefully examined
and exercises directed by selections from the accompanying

GYMNASIUM PRESCRIPTION.

ORTHOPAEDIC DEPARTMENT UNIVERSITY HOSPITAL.

tment Desired. Give Full Instructions as to Massage and Muscular Movements.

.....

.....

	AGE	SURGEON	DATE	TREATMENTS WEEKLY

.....Rotations.....	29. Wands
al Massage	30. Guns
lassage	31. Striking Bag
Movements	32. Lat. Curv. Bicycle
al Movements	33. Mechanical Bicycle
pander	34. Abdominal Stool
ubs	35. Leg Rotating Machine
mb-bells	36. Leg Circling Machine
umb-bells	37. Flexor Foot and Ankle Machine
ar Bells	38. Foot Circumduction Machine
	39. Return Foot-ball
Circle	40. Balance Board
Machine	41. Double Staircase
coliosis Appliance	42. Spring Board
Scoliosis Appliance	43. Trolley Support
Scoliosis Appliance	44. Spring Swing
Side Bars	45. Mechanical Swing
Chest Weight	46. Finger Machine
Exerciser	47. Pronator and Supinator Machine
ectric Exerciser	48. Arm Machine
	49. Wrist Roller
rapeze	50. Grip Machine
ension	51. Punch-ball
v. Manual Pressure Board	52. Exercising Rings
	53. Spirometer
Plinth	54. Grace Hoops, Quoits, Bean Bags, etc.
Back-board	55. Superheated Air Appliance
Rope	56. Vibratile

FREE EXERCISES.[1]

k.....*Deep breathing (repeat 5 times).*
k.....*Head bending and turning.*
k.....*Shoulder rolling.*
k.....*Leg circling.*
.....*Leg circling.*
.....*Foot circling.*
nd extended beyond edge of couch. *Head bending.*

[1] ...cises have been kindly prepared by Miss Anna S. Kite, **Physical Director,** ...tal Orthopaedic Gymnasium and Widener School for **Crippled Children.**

VOLUNTARY EXERCISES.

Free Exercises—*Continued.*

Lying on face	*Backward bendi* ing.
Lying on face	*Trunk rotating.*
Lying on side	*Sidewise bending.*
Lying on back	*Trunk raising.*
Lying on back	*Leg raising.*

Hyperextension Work.

Lying prone with trunk extended BEYOND edge of couch or table or plinth, feet held firmly	*Trunk forward and backwa*
Same position	*Trunk rotating.*
Lying on side with trunk extended	*Trunk sideways bending.*
Lying supine with trunk extended	*Trunk forward and back*
Standing	*Keynote forming.*
Standing, keynote position, trunk erect	*Trunk sideways bending.*
Standing, keynote position with trunk bent slightly forward	*Trunk sideways bending.*
Standing, keynote position with trunk bent forward until it forms right angle with the legs	*Trunk sideways bending.*
Standing, keynote position	*Trunk backward bending.*
Same position	*Trunk rotating.*
Standing in keynote position, trunk erect	*Rotation and backward bendings.*

Wand and Bar Bell Exercises.

Wand held in both hands in front of body	*Carry to overhead, then back of* reverse.
Wand held erect above head	*Step diagonally forward to right an*
Wand back of waist	*Swing laterally, right hand up,* to level, then left up.
Wand diagonally back of the body	*Step diagonally forward to right and left.*
Wand back of the shoulders with palms of hands back	*Thrust wand down.*
Wand in the neck-rest position	*Thrust the wand upward.*
Wand in the neck-rest position	*Trunk forward and backward bend.*
Wand down in front of the body	*Swing laterally to right and left alternately.*
Wand with arms in keynote position	*Trunk forward and backward bend.*
Same position	*Trunk sideways bend.*
Same position	*Trunk rotate.*
Same position	*Trunk rotate and backward bend.*
Same position	*Step diagonally forward and trunk forward bend.*
Same position	*Heels raise, knees bend, knees stretch, heels sink.*
Standing, wand in front of shoulders	*Stretch to side, back to position, then forward stretch and back to position.*

Light Dumb-Bell Exercises.

Bell or bells held at the sides	*Push up to full stretch while stepping diagonally forward.*
Same position	*Stretch high on the toes while breathing deeply.*
Same position	*Carry arms backward.*
Same position	*Carry arms backward and trunk forward bend.*
Lying on back, bells at sides	*Carry arms forward and up alongside of head.*

ROTARY LATERAL CURVATURE.

LIGHT DUMB-BELL EXERCISES—*Continued.*

.....	*Carry outward and upward alongside the head.*
ells at shoulder level.....	*Arms rotate.*
eld at sides.....	*Trunk forward bend, placing bells on floor. Up, then bend and pick up bells.*
est position, holding one bell.....	*Trunk forward and backward bend.*
les.....	*Arms circling backward.*
.....	*Carry to shoulder level, rising on toes, stretch out to sides and back to position, lowering heels.*
rms crossed on chest.....	*Carry out to sides and down to sides.*
rms keynote.....	*Trunk forward and backward bend.*
.....	*Trunk sideways bend.*
.....	*Trunk rotate.*
.....	*Trunk rotate and backward bend.*
....	*Step diagonally forward and trunk forward bend.*
e, arms alongside body.....	*Carry arms backward.*
e, arms level with the shoulders...	*Carry arms backward.*
t sides.....	*Heels raise, knees bend, knees stretch, heels sink.*

es are treated by muscular exercises alone, and with special pparatus; others with plaster jackets, removed only during ic movements (p. 279). More severe cases, rigid cases, and tations are treated by forcible measures combined with gym- 200).

l gown is provided with back detachable as a flap, for ready d supervision (Fig. 201). During menstruation the exercises or lessened. The first muscular exercises are given prone or flat rattan couch (Fig. 202).

ct of carrying objects on the head is well illustrated in the nd shoulders of peasants in foreign countries and of negroes and. When loaded to excess the weight is of course serious, ing of light sand bags and afterwards of a book (which may to a large atlas) upon the head while walking is a decided rfecting carriage.

tient standing in front of a mirror, the surgeon or instructor nstrate to the child the importance of maintaining the best ion and carriage and she should be induced to perform these y times daily in the improved position. Striking the knuckles ind the back with thumbs up is also a good exercise. Lateral the instructor's hand or the patient's own hand upon the pro- on of the thorax, is another valuable movement.

que step, arms keynote, for left lumbar or left total curve is ce left foot forward and outward; flex left knee; bend body obliquely to left; back to original position; repeat ten times. se tilts the pelvis downward, bringing its transverse axis into e hyperextended and abducted thigh, thus correcting and he lumbar curve. The psoas muscle attached to the hyper- igh also pulls upon and rotates the lumbar vertebræ. The

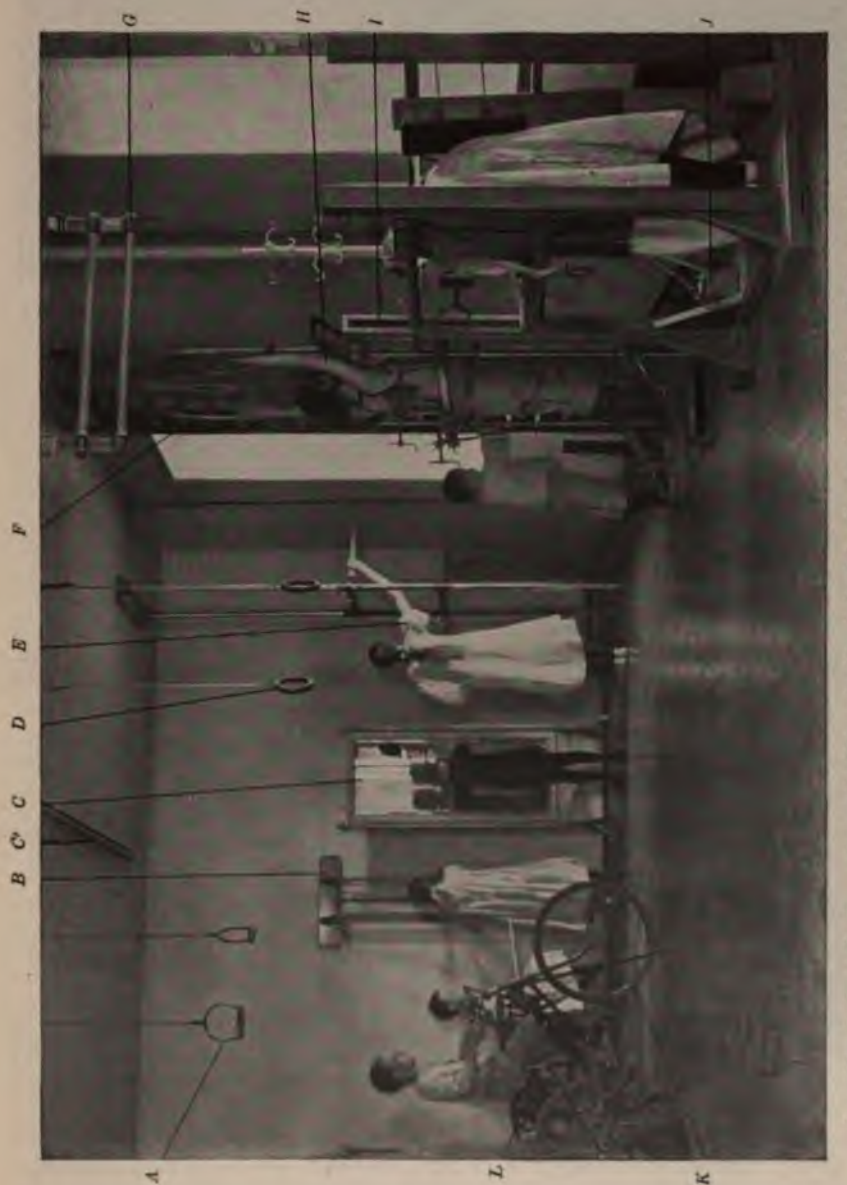

FIG. 200.—Orthopaedic Gymnasium at the University Hospital. *A*, handles attached to pulleys; *B*, chest weight; *C'*, trolley track in ceiling for support of paralytic cases; *C*, pier mirror; *D*, unequal rings; *E*, fulcrum; *F*, Swedish side bars; *G*, double barred trapeze; *H*, Weigel's scoliosis correction appliance; *I J*, Beely's scoliosis correction appliance; *K*, stationary bicycle for paralytics, run by electric motor or voluntarily; *L*, vibratile massage machine. (See also Fig. 152, p. 235.)

forward flexion to the left stretches the muscles of the concave side, forcing rotation of vertebral bodies in the opposite direction and increasing mobility and muscular power."[1]

In young children, and in fact in the majority of patients, it is impossible to secure the adequate amount of corrective training unless definite hours are set aside under the care of a special instructor. For young children the exercises must be made to include the element of play; spring swings, hand-propelled swings and spring boards are exceedingly useful. For little children the swing

FIG. 201.—Gymnasium gown with detachable rear flap permitting ready examination of back. (Kite.)

FIG. 202.—Voluntary muscular exercises while lying prone on flat rattan couch.

FIG. 203.—Model of child's swing. Movable hollow hand-pieces slide upon the perpendicular ropes. Cords passing from these hand-pieces to wooden arms permit child to swing herself. Excellent for out-door exercise.

[1] Whitman, Orth. Surg., 201, 3d ed.

depicted in Fig. 203 is attractive. It can be readily made by anyone and consists only of a pair of wooden hand-pieces sliding up and down the main ropes of the swing, these hand-pieces being attached by a cord to wooden arms extending twelve inches in advance of the suspension points of the swing. Musical dumb-bells, return hand- and foot-balls, and punching bags are of service in addition to ordinary dumb-bells, clubs, guns.

The best voluntary corrective position being taken as the keynote position (Fig. 204), the patient's shoulders and trunk should be flexed

FIG. 204. — Best voluntary muscular correction of scoliosis

FIG. 205. — A series of lateral movements of body with arms in keynote L position for right dorsal curve.

FIG. 206. — Lateral movements in reversed keynote J position for left dorsal curve.

FIG. 207. — Flexion of trunk at hips, with rotation movements in bent position.

backward, forward and laterally (Figs. 205 and 206); then should follow rotations with the body in both the erect and flexed position (Fig. 207). In the position of hyperextension, with hand behind the neck, flexions (Fig. 204), rotations and leg movements are employed. The muscles upon the concave side of the curve receive special attention by one-arm work. A chest weight or a Whitely exerciser can have attachments for

hands, feet, head and neck. In the chest weight work, the scapular and serrate muscles may be brought into play at the termination of the pull. An endless rope, supplied with friction brake upon the pulley, is helpful. Pressure over the convexity of the ribs by a fulcrum or padded roll or strap will greatly assist the instructor; the same may be said of mechanical massage. A flat rattan couch three feet high is used for dorsal and prone movements to save the back of the instructor. The exercises may be given equally or unequally to the two sides of the body.

FIG. 208.—Lateral raising of trunk in keynote L position, with body overhanging rattan couch and with feet strapped.

The *keynote* position for symmetrical work is "U"; *i.e.*, arms extended alongside the head; for unilateral exercises L or ⅃ (reversed L), one arm raised and the other at right angles to body, as viewed from the rear (Figs. 184, 185 and 186, p. 260). These positions are tested to determine their effect on correction of the deformity in the erect, prone and flexed positions. Lateral bendings and rotations to the right and left, with pelvis fixed by the instructor or by clamps, are also tested in the prone, erect and flexed positions, and exercises prescribed in accordance with findings. The best results secured are then carried out with patient lying prone on couch, the feet being firmly held by instructor. At first, raising and lateral movements of upper trunk are made (Fig. 208) assisted by the instructor; later, voluntary movements are prescribed; still later, as strength develops, with legs strapped to couch, the patient's body above the pelvis overhanging the end, all the movements of the spine are repeated both in prone and supine positions.

The work should always be light at first, each movement being repeated five to ten times. When tired, the patient should rest flat upon the back.

FIG. 209.—Backward flexions to increase flexibility of spine.

HEAVY DUMB-BELLS. — Vigorous, rapid, progressive exercises with heavy dumb-bells up to fifty or sixty pounds have been practised by Teschner,[1] Ehrich, Twinch and others.

IV. INCREASE OF BACKWARD AND LATERAL FLEXIBILITY is obtained by lateral and backward flexions (Fig. 209) over a fulcrum or bar or

[1] Ann. Surg., Aug., 1895.

over the hand of the instructor or by bridle and quarter circle[1] (Fig. 152, p. 235), or by the hyperextension movements above scheduled.

The patient, when sufficiently strong, may also overhang the couch, with bending of trunk toward the floor (Fig. 210), and raising it voluntarily to above the level (Fig. 211).

FIG. 210.—Forward flexion over end of couch with feet held by instructor.

Other efficient apparatus for muscular developments are furnished by chest weights, Whitely exercisers, light dumb-bells, Indian clubs, wands (Fig. 212), guns, endless rope, Swedish side bar (Fig. 213), ladder, back-board (Fig. 214), plinth, head-balancing board, bridle, lateral curvature bicycle with slanting seat, self-suspension from head (Fig. 215), deep breathing, etc., etc. (see prescription, p. 268). Vibratory machine massage (Fig. 552, p. 618) or better, manual massage of the muscles of the back, with patient prone, is given at the completion of the treatment, with hot or cold shower bath, after which a rest in horizontal position is desirable for half an hour.

FIG. 211.—Voluntary lifting of body from flexed position over end of couch as seen in Fig. 210.

When the patient is discharged, an outline of home treatment should be carefully written out and daily use prescribed for months. These exercises should be largely voluntary, but if the patient can afford dumb-bells, clubs, chest weight or Whitely exerciser, trapeze or rings (Fig. 200), self-suspension or yoke, they are all advisable. The dorsal and prone couch exercises already described can be practised over the edge of a bed, or better, from a table.

Self-suspension by head gear with compound pulley is very advantageous (Fig. 215). The patient should raise herself to the tips of her toes with her hands fully extended above her head and should remain in this position as long as she can do so without pain. This should be repeated several times in the day. The hand on the CONCAVE side should always

[1] Article by author, Ashhurst's Internat. Encycl. Surgery, vii, 541–560.

be UPPERMOST upon the pulley rope. The spine may also be extended and both curves and rotation benefited by fixing the scapula and securing the action of the serratus magnus upon the vertebræ, by hanging

FIG. 212.—Wand exercise, see p. 269

FIG. 213.—Swedish side-bar ladder. Right hand in advance of left for left lateral curvature.

FIG. 214.—Backboard exercise for scoliosis and for round shoulders.

upon the trapeze or rings so that the arm of the concave side will bear the greatest amount of strain. The horizontal bar can be used for hanging by the same hand, or a double bar may be employed. [illegible] either

rings or trapeze the patient, with feet stationary, can carry the body laterally toward the concave side while forcible pressure is made upon the convexity of the trunk. Circular motions are also used in this position.

V. Mechanical Support by Jackets Combined with Gymnastic Exercises.—For advanced cases with rotations, more complicated methods are required. Forcible correction is followed by support with a plaster jacket maintained all the time that the patient is erect, which support must be assisted by daily gymnastic strengthening of muscles. Muscular increase of power is the curative agent, the jacket is intended only as a support to prevent relapse during the hours when the patient is not in the gymnasium. Many methods of securing this desideratum have been devised. The simplest is that of Elmer. A gas-pipe frame with extension ratchet bar at one end is provided; upon this a strong muslin sling is fixed with safety-pins at the foot, and tightened at the head by the ratchet. A tight tubular stockinet encloses the trunk and is left long enough to cover the outside of the cast. With a bridle at the head and leather foot-pieces at the ankles, extension is made by pulleys (Fig. 216) upward and downward while the plaster cast is applied. In this prone position much greater relaxation of muscles is secured than when the patient is suspended by the head. The thickened lower border of the cast should enclose the pelvis above the great trochanters and the upper border is strengthened below the axilla. When hardened, the jacket is cut down the median line in front, trimmed under armpits and at the groins and bound

Fig. 215.—Self suspension by head with pulley, with toes touching floor.

Fig. 216.—Extension frame, patient lying on face with head and foot pulley extension.

with adhesive plaster or leather[1] (Figs. 217 and 218). It can then be removed for daily gymnastic exercises as above detailed (p. 273).

[1] Elmer, Archiv. Pediatrics, Feb., 1909.

FIG. 217.—Compound lateral curvature with rotation, corrective jacket applied during horizontal extension from head and feet (see Fig. 216); made removable for daily gymnastic exercises. (Elmer.)

FIG. 218.—Removable plaster jacket applied during horizontal extension. Reapplied daily after exercises.

VI. Leather or Felt Jackets.—After a series of increasingly straightened jackets applied every month or two, those who can afford it may have a leather, felt or aluminum jacket. A neater support (Fig. 219) can be made over a plaster mold which is shaped and partially conformed to the normal trunk by shaving away projecting areas and filling in depressions with plaster cream.[1] Such a leather jacket need not weigh over three pounds [2] and should be worn for at least a year, the gymnastic exercises being continued after that time once a week for another year—in fact, every case of lateral curvature of severe grade should be watched closely until full growth is attained.

Fig. 219.—Leather jacket worn after several months of corrective muscular exercises. Spine practically straight (see Figs. 183 and 190) (Elmer).

All corrective casts that produce pressure, if continued for years without muscular development are liable to produce atrophy, while muscle vigor is the most essential element in permanent success.

Bradford[3] employs a corrective removable plaster cast, or a leather or celluloid brace made upon a mold of the body, with truss spring for diagonal pressure.

VII. Forcible Straightening by Mechanical and Hand Pressure.—This may be done with patient erect or suspended (Fig. 215), or resting upon the abdomen in the flexed position, with legs overhanging the table. Forcible correction can be made by the hands of the instructor or by means of straps or pads, or by the patient being bent laterally across

[1] Ann. Surg., July, 1889.
[2] Elmer, Archives Pediatrics, Feb., 1909.
[3] Amer. Jour. Orth. Surg., Apr., 1908 450.

a padded bar pressing upon the thoracic projection, the arms grasping the framework above. This forcible correction may also be accomplished by the apparatus of Bradford or Weigel with adjustable pads and screw

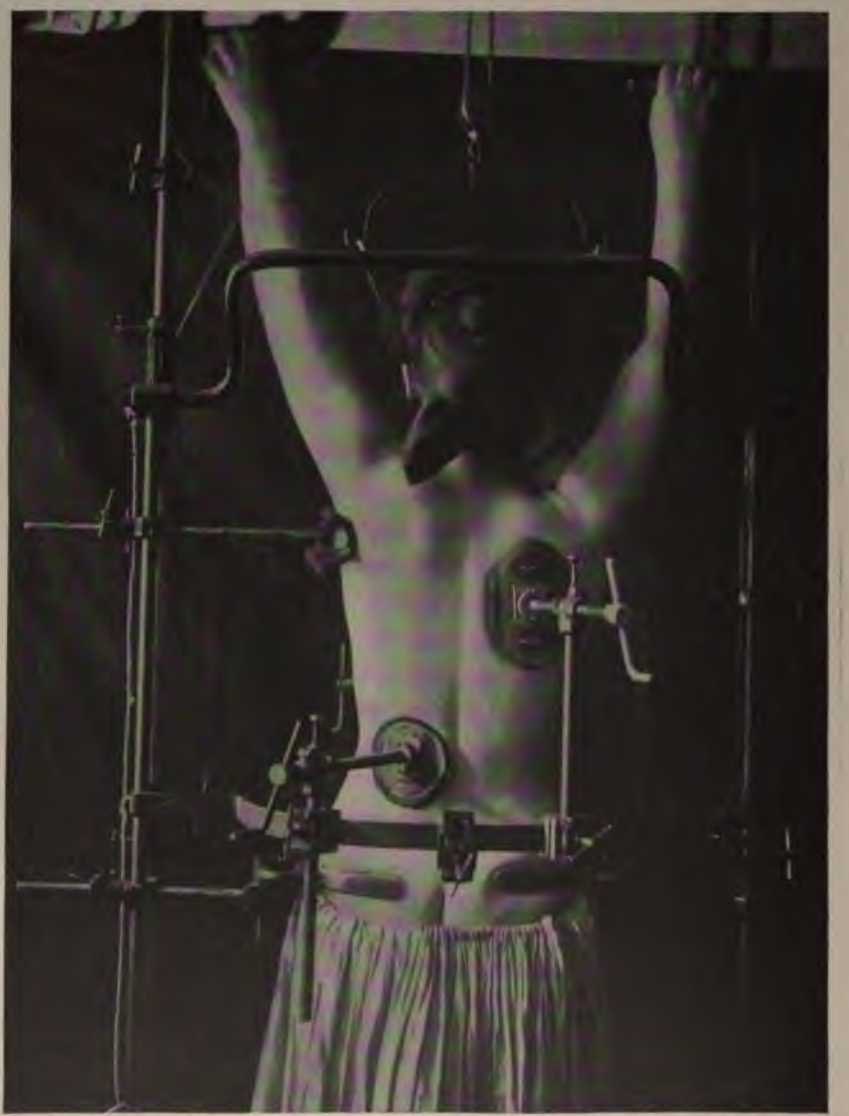

FIG. 220.—Weigel's powerful corrective appliance for cases of rigid scoliosis. Patient extended by head and arms while pressure is made upon projecting regions.

force, hips, shoulders and head being confined (Fig. 220). Another method is the appliance of Beely, as shown in Fig. 221, the shoulders and pelvis being fixed and pressure made by straps across the projecting dorsal and lumbar regions with the body flexed. These straps may be weighted according to the endurance of the patient, twenty-five

to one hundred and fifty pounds. Other appliances are those of Lovett,[1] Taylor, Nebel and others.[2] Wullstein encloses the whole trunk together with shoulders, neck and head in a plaster jacket.

EXTREME cases of rotary lateral curvature that have become RIGID and fixed present a more difficult problem for treatment. Not only are the vertebral bodies curved and rotated and distorted (Fig. 222), but the laminæ are twisted, the intervertebral cartilages are wedge-shaped, the ligaments contracted or stretched and the articulating facets displaced. Added to these spinal deformities, all the twenty-four ribs are deformed, with great posterior projection on one side and flattening on the other. On one side, the lower ribs may impinge upon the crest of the ilium. The thoracic and abdominal organs are compressed and displaced and the whole trunk presents a rigid, inflexible mass. Such a deformity might perhaps be corrected if manual pressure could be continued uninterruptedly for many months, but since this is impossible, it is evident that only partial straightening can be secured.

FIG. 221.—Beely's corrective appliance for rigid lateral curvature. Pressure made upon projecting regions by broad straps and heavy weights, while body is flexed at hips.

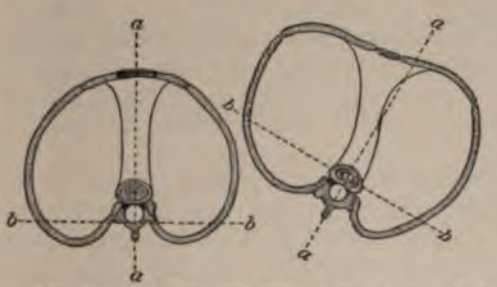

FIG. 222.—Normal and rotated vertebræ. Axes *aa* and *bb* in right hand figure show marked distortion of thorax.

All the corrective methods previously described are to be employed with vigor. Forcible correction is most effective when made with the trunk prone upon a bed-frame supported on trestles with thighs flexed on body. Forcible correction is only a part of the corrective process, as muscular development is more important.[3] Torsions and side bendings are most helpful in the dorsal extended positions. Forcible corrections may also be made by lever and weights upon projecting ribs, with patient prone[4] or erect. The powerful appliances of Figs. 220 and 221 are very useful.

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[1] Jour. Amer. Med. Assoc., June 23, 1906, 1915; Jour. Am. Orth. Surg., May, 1910.

[2] Bost. Med. and Surg. Jour., Aug. 6, 1903.

[3] Hoffman, Trans. Amer. Orth. Assoc., 1900, 61; Bost. Med. and Surg. Jour., Oct. 31, 1901, and June 14, 1900.

[4] Feiss, Ohio State Med. Jour., June, 1907, and Jan., 1907.

PPORT BY BRACES AND CORSETS.—The apparatus that have for the correction of lateral curvature would fill a room. As orrection they are practically useless unless combined with rcises as described on the previous pages, but when discrim- d they may be made valuable. As a support and improve- gure in old confirmed and fixed cases they are of service, and o the patient to correct and maintain the best position, even nity, they are sometimes valuable in careless cases. Surgeons, instrument makers, forget that the pelvic arch, which must the base of support, is an irregular bony structure covered vulnerable points, the crests and anterior superior spinous by skin and connective tissue incapable of bearing serious ntinued pressure. Upon such an unstable foundation it is erect any appliance capable of carrying the weight of the head and at the same time applying sufficient lateral force coliosis. STEEL APPLIANCES have been made to press upon tly distorted parts, and all sorts of screws and mechanical been invented, but one has but to examine them in position ght is their corrective power. Cure and correction can only improved muscular action, gymnastic training, straightening the mobility of the spine by the described methods. The ermanent appliance is the removable leather, felt, aluminum ket made over a plaster torso which has been modified and a cast taken in the best possible position (Fig. 219).

RATIVE MEASURES.—Hoke has advocated resection of ribs to permit of greater flexibility of the trunk,[1] but few patients such an operation and few surgeons would advise it. Hoffa[2] have also performed resection of ribs. Tenotomy of muscles n advisable.[3]

.—(1) In slight and beginning postural curves, cure can be arefully regulated muscular training under thorough super- roperly equipped orthopaedic gymnasium. Personal habits d position and earnest coöperation on the part of the patient .

ses of curvature with slight rotation, the best results can be ily gymnastic exercises, combined during the intervals with series of plaster jackets applied during correction in the hori- n. Progressive correction is secured by monthly application mproved positions.

ked changes of structure, forcible correction and long reten- s, combined with muscular improvement, will give increased l relief from pain.

d inveterate cases, improvement of figure can be secured by r by light leather or aluminum or felt jackets fashioned over ximating the normal figure.

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[1] Amer. Jour. Orth. Surg., Nov., 1903, 168.
[2] Hoffa, Zeitschrift f. Orth. Surg., 1896, 401.
[3] Shaffer, Amer. Surg. Bulletin, Jan. 1, 1894.

ROUND SHOULDERS; STOOP SHOULI

Round shoulders may be due to abnormal configura and neck or to muscular debilities or to faulty attitudes relation of the feet, legs, pelvis, spine and head[1] (Fig. 223).

Round shoulders are usually attributed to shortened pectorals or serrati.[2] In certain cases, also, short or arched acromioclavicular ligaments are found which prevent the backward movements of the shoulder.

Treatment.—The patient's pride and ambition must be aroused to realize the importance of a correct carriage and posture. Skirts and trousers should be suspended from the waist, not from the shoulders. Carrying a light weight on the head, hanging by arms from bar or rings or trapeze, gymnastic exercises with bridle, quarter circle, bar, English backboard are most helpful (Fig. 200, p 271).

The rhomboids and trapezius should be developed by chest weight, dumb-bells and backward flexions.[3] A shortened serratus should be stretched. Backward flexibility of the dorsal region is acquired by the movements prescribed for lateral curvature (p. 267). The best apparatus is a back brace made of light spring-steel with loops over the shoulders so as to exert a constant pressure backward and remind the patient of the necessity for personal exertion. In severe and rigid cases forcible correction is necessary[4] or the coracoclavicular ligament may be divid with a double edged tenotome, carefully avoiding the vessels.[5] Correction of posture, locomotion, etc., should be general and involve the entire muscular system. This condition of high dorsal kyphosis is best remedied by the application of the principles laid down for long dorsal kyphosis and for lateral curvature (p. 267) with special attention to carriage upon the part of the individual.

Fig. shoulder chest fro ural habit.

[1] Goldthwait, Am. Jour. Orth. Surg., i, 65.
[2] Fitz, Bost. Med. and Surg. Jour., cliv, 423.
[3] Lovett, Bost. Med. and Surg. Jour., Nov. 6, 1902.
[4] Amer. Jour. Orth. Surg., vol. ii, No. 3, 273.
[5] Amer. Jour. Orth. Surg., i, No. 1, 65; Bost. Med. and Surg. Jour., Nov. 6, 1902.

CHAPTER X.

CONSTITUTIONAL DISEASES PRODUCTIVE OF DEFORMITIES.

RICKETS.

Synonyms: Rhachitis (ῥάχις spine, and ιτις inflammation)—Englische Krankheit.

RICKETS is a disease of defective nutrition from malassimilation of food, especially caused by the absence of sunshine and fresh air. Rhachitismus is the general term applied to this condition. It usually occurs in early life but sometimes in late puberty. In its early stage it is characterized by many evidences of malnutrition, digestive disturbances, softening of bones with marked deformities in the skeleton and later hardening of bone tissue (Fig. 224).

FIG. 224.—Rickety deformity of femur and knee. Note the wide cartilaginous epiphyseal line, not to be mistaken for fracture.

Some authorities believe rickets to be due to toxins received by the child through the tuberculous placenta of the mother. To the surgeon the chief importance of the condition lies in the prevention and correction of the resultant bone distortions.

In certain localities, even when the children are fed entirely on starchy foods and live in unhygienic surroundings, rickets is uncommon, probably due to the fact that in the Tropics life is largely spent in the sunshine and fresh air, yet in the Arctic regions the condition is not common in spite of the indoor life. From 6 per cent. to 10 per cent. of sick children are rickety.

FETAL OR INTRA-UTERINE OR CONGENITAL RICKETS is occasionally met with after exhaustive diseases in the mother or syphilis in the father. The rickety peculiarities exist at birth and differ slightly from chondrodystrophia (p. 319).

LATE RICKETS is a condition of malnutrition possibly from tuberculous non-resistive cells which, while not pathologically distinctive, is a clinical entity when combined with occupational causes. In adolescents or adults, distortions of the lower limbs may be produced, requiring osteotomies for relief (Coxa Vara, p. 311). Enteroptosis is not an uncommon accompanying condition.

Causes.—Rickets is essentially a constitutional disease. In healthy countries it so rarely occurs it is often overlooked by attending physicians. The chief causes are malassimilation and defective digestion. In the poor it is readily accounted for by the absence of sunlight and fresh air, by overcrowding in tenements, and prolonged lactation especially during frequent pregnancies. In the rich it is the result of non-attention to hygienic surroundings, the faulty administration of foods, and the neglect of mothers in failing to nurse their children. Exhaustive disease in the mother during pregnancy, or later in the child, may lead to this malnutrition. A child that is late in walking, even though fat, is often rachitic. In the colored race, especially mulattoes and in this country among Italians, Russians, Jews and Portuguese, the disease is common. It exists in proportion to the amount of filth, squalor, bad air, scanty food and lack of sunshine. In Europe and Great Britain the disease is more frequent and of a more severe type than in the United States. In New York where the poor are crowded into dark badly ventilated tenements, it is much more prevalent than in Philadelphia where the laborers live in their individual small houses. Every one is familiar with the pale, feeble appearance of plants deprived of light for even a short time. It is possible that the arrest of the ultra-violet rays by glass windows may act as a partial deprivation. Next to the absence of sunlight and air, improper food is among the most prolific causes. So long as children under two years of age are stuffed with table food, so long will rickets abound and the exaggerated dangers of the "second summer" be feared. Syphilis, tuberculosis and rickets are distinct diseases, yet either of the former two in the mother or father may lead to the latter by inducing malassimilation. Individuals insufficiently supplied with common salt are liable to rickets.

Pathology. — In addition to general constitutional evidences of disturbance of internal organs, the bone changes consist, in the early stage, of bone softenings. Great vascularization of the epiphyseal lines of the medulla and of the periosteum mark the primary steps. This stage is followed by hyperplasia and over-production of the proliferating cartilage cells, defective calcification owing to the faulty deposition of lime salts, and the deposition of osteoid tissue beneath the periosteum. In the stage of softening, the organic bone material is largely in excess over the inorganic. When this process is arrested, rapid and abnormal ossification follows and the bones become eburnated—the condition of sclerosis. This early and excessive ossification of the epiphyseal lines interferes with the growth of the child and permanent hyperostosis results. Rickets exerts a decided influence upon bone marrow by decreasing its functional activity.

The relation of the sometimes present anemia of rickets to anemia infantum, pseudoleukemia or splenic anemia of infants—anemia splenica infettiva—has yet to be demonstrated. The proportion of the red cells to the leucocytes is not seriously altered in rickets.[1]

Symptoms.—The disease seldom develops before six months or later than three years. In the acute stage the tenderness of the epiphyses causes the child to cry whenever handled. It is listless, prefers to lie quietly and does not attempt to walk until late and is restless at night with hot

[1] Lancet, Blood Examination, April 24, 1909.

limbs. Excessive sweating of the head, rapid ammoniacal fermentations of profuse urine and persistent constipation, should be looked upon as precursors of rhachitis. Dentition is delayed and the teeth decay rapidly, but are not as notched as the Hutchinson teeth of syphilis. Nervous symptoms are common, including convulsions. The spleen is sometimes enlarged. The great enlargement of the abdomen may produce a diastasis of the recti muscles. Defective digestion and malassimilation are constant. The gastro-intestinal fermentation may be the cause of the developing ptomaines and toxins which are responsible for the disease. In a typical case the beaded ribs, narrow chest, large abdomen, large head and enlargement of epiphyses of bones are characteristic, but any of these peculiarities may be absent and in a few cases the symptoms may be scarcely noticeable.

FIG. 225.—Rickety flat chest and prominent abdomen.

Deformities.—The distortions of bones during the stage of softening that especially concern the surgeon, come from faulty positions, muscular action, weight-bearing and atmospheric pressure. In infant life, kyphosis of the spine and lateral curvature result from faulty carrying or from too early attempts at sitting. The head is large, square (caput quadratum), with open fontanelles and prominent frontal eminences. Posteriorly, softened areas—craniotabes—can be felt. The radial and ulnar epiphyses are enlarged and both lower and upper arms and clavicles become curved by attempts to support the body in a sitting position or by creeping. At the elbow, cubitus valgus or varus may result. At the junction of the ribs and costal cartilages, bony enlargements give the "rickety rosary" with longitudinal groove or depression of the sternum, funnel chest (Fig. 225), or sternal prominence,—pigeon- or chicken-breast (p. 108). The transverse groove known as Harrison's line is formed as the lower ribs are thrust outward. Anterior curvature of the tibia and bow-legs or knock-knees are developed from cross-legged or other positions in sitting (Fig. 226), and are increased as soon as the child commences to walk. The softening of the pelvis, with increase of the sacral promontory and narrowing of the anteroposterior and lateral diameters, is later of most serious import in females, endangering the life of both mother and child, by necessitating Cæsarean section, symphysiotomy or craniotomy. The long kyphotic curve of the spine in rickets differs from the angular curve of spinal caries, but resembles the long curve seen in feeble spastic children.

FIG. 226.—Rickety cross-legged position caused by sitting on floor in infancy.

LORDOSIS.—A forward curve of the spine in the lumbar region may be the result of rhachitis, of congenital malformation of the heads of the femurs, or of spondylolithesis. Its cause should be first diagnosed. Cases of lordosis will be sent to the orthopaedic surgeon when the deformity is but the result of other conditions. A lordosis must necessarily be present when any contraction of the psoas muscle exists, either from hip disease or hip ankylosis or spinal caries or from muscle weakness as in dystrophy. It may also be compensatory to a kyphosis in the upper region of the spine.

FIG. 227.—Curvatures of legs, thighs and arms due to early malnutrition and rickets.

Diagnosis.—The symptoms of malnutrition may be present either in CONGENITAL SYPHILIS or in rickets, but the former usually shows itself soon after birth; rickets later, after the sixth month.

FIG. 228.—Double knock-knee with sharp curve in tibiæ; flat-feet.

Beading of the ribs is found in rickets, not in syphilis. Bony deficiencies, especially of the fontanelles, are common in rickets. The tenderness in rickets is at the epiphyses and dactylitis is rare. The diagnosis between syphilitic and tuberculous spondylitis is difficult in young infants unless there are other evidences of syphilis, but fortunately in both diseases the mechanical treatment is the same, *i.e.*, complete rest and fixation.

TUBERCULOSIS of joints in older children shows more rigidity and fixation of the articulation, less firm thickening of the epiphyses. In rickets the tender epiphyses, beaded ribs, softened skull, open fontanelles, are distinctive. The diagnosis from RHEUMATISM at the early stage, is made by the absence of heat, redness and temperature, and by swelling and tenderness of the epiphyses rather than of joints. The initial stage of INFANTILE SPINAL PARALYSIS is marked by tenderness of muscles rather than of bones, while paralysis will be present and the symptoms of rickets absent. In GENERAL WEAKNESS from disease, the rhachitic symptoms, the

rickety rosary, the softened occiput, the dolicocephalic skull, excessive head sweatings, flabby muscles and enlarged epiphyses will be at least partially absent.

Prognosis.—Recovery is quite certain if proper food, air and surroundings can be secured.

The rhachitic child ordinarily and fortunately does not willingly walk until about the third year. If permitted to rise from the dorsal posture, deformed arms (Fig. 227) and spine are probable; if allowed to walk, knock-knee (Fig. 228), bow-legs (Fig. 229) or flat-foot will be produced. The prognosis of these latter conditions is given under their respective headings. Pigeon and funnel chest are likely to be permanent. Growth will be lessened.

FIG. 229.— Double out-knee and bowlegs; outer ligaments at knee stretched and condyles elongated.

Treatment.—(1) Dietetic; (2) hygienic; (3) prevention of deformities; (4) cure of deformities, (a) manipulative, (b) mechanical, (c) operative.

1. In the early stage constitutional treatment is of extreme importance. Every attention must be given to the securing of an outdoor sunshiny life and the adoption of proper and digestible food. Milk with an extra portion of cream is the safest food for young children. Healthy mother's milk is certainly preferable, or that of a clean wet-nurse, but of course the child should be weaned if the mother becomes pregnant. As children differ greatly in their powers of digestion, dietary information concerning the many prepared milks and foods should be sought in paediatric treatises. The use of condensed milk is prohibited by many authorities, but for a child compelled to change its residence frequently or to depend upon uncertain supplies, a reliable condensed brand offers the safest and most uniform food. Many of our strongest and healthiest young men were raised on condensed milk.

Rickety or other digestive consequences are certain to follow the too common practice of allowing the child, in its second year, to come to the table and receive a mixed diet. Milk, and later, a little animal food are entirely requisite for its needs. After the third year butter in large quantities is more palatable, less disturbing to digestion and equally as beneficial as codliver oil. When fat disagrees, a few drops of ether, or a regulated dose of pepsin or of mercuric bichloride ($\frac{1}{3000}$) will assist digestion. Cream may be taken freely but starchy foods should be prohibited. Plenty of salt and limewater are helpful. Overfeeding should be avoided especially when but little exercise in the open air is possible. Milk, eggs and meat should be given judiciously, according to the age of the child and its powers of digestion. Vegetables, fruits, orange juice, bread made of whole wheat,

and spinach that combines iron and lime, can be used freely in children over three years of age; but sweets very moderately.

The absence of rickets in Japan is attributed by some authors to the free use of fish by the populace.

MEDICINES are of secondary importance to food and fresh air, but iron, arsenic, phosphorus, sulpho-guiacolate of potassium,[1] lactophosphate of lime and codliver oil may be given. Phosphorized olive and codliver oil are useful provided the stomach is able to assimilate them. If emulsified or given in pepsin, they will be better borne. (See Inherited Syphilis, p.318.)

2. HYGIENIC.—The child should be warmly dressed and should live out of doors as much as possible, directly exposed to the rays of the sun by day, and sleep upon a porch at night. The bed and pillow should be

FIG. 230.—Epstein rocking-chair for support and strengthening of muscles of the relaxed curved spine of rickety deformity (Pfaundler and Schlossmann).

hard. All of the conditions of out-door life described on p. 380 for tuberculosis are equally helpful for rickets. A change to seashore or mountains for a long period of time is desirable.

3. PREVENTION OF DEFORMITIES.—A young child unable to sit can be placed out of doors upon a canvas tray of bamboo or wood or gas-pipe on trestles or on four wheels (p. 424). Massage with olive or codliver oil and manipulative straightening daily, will benefit.

During all the stage of softening, weight-bearing upon spine, arms or legs must be carefully avoided, and the child kept upon its back, since lateral curvature and kyphosis, bendings of arms and clavicles from the sitting posture are exceedingly common. If the child sits or walks, deformities are almost certain to occur. The prone and supine recumbent positions, therefore, must be maintained until constitutional and hygienic measures have conquered the disease. A weak rickety spine can be strengthened by sitting in a rocking chair (Fig. 230).

[1] Therap. Monatschr., July, 1907.

The benefits of manipulation are described under Knock-knee and Bow-legs (p. 304). When the child begins to walk, supporting apparatus is applied if the slightest tendency to distortion is noticed.

Fig. 231.—Bowing of forearms, arms, and legs.

4. Cure of Deformities.—The manipulative, mechanical and operative treatment of knock-knee, bow-legs, coxa vara, etc., will be separately discussed.

Subcutaneous osteotomy of the clavicle is not advisable on account of the close proximity of the large vessels. If an operation is necessary, the bone should be exposed by an open incision. In rhachitic dislocations or laxity of ligaments at the clavicle, Gibney advises local injections of alcohol.

Osteotomy of the humerus is rarely necessary; when performed it should be through an incision and great care observed not to injure the musculo-spiral or other nerves.

Osteotomy of the radius and ulna is sometimes necessary for rickety or other deformities of these bones (Fig. 231). The sharpest point of bending is usually the lower third. Great improvement both in appearance and in strength may be expected.

Osteotomy of the articulations of the vertebræ and ribs has been performed for lateral curvature, but the result is not encouraging.

Osteotomy of the ramus of the pubes has been practised to enlarge the pelvis in labor, but symphysiotomy has largely taken its place. The latter is liable to result in a weakened pelvis.

An Adams' subcutaneous (Fig. 162 *D* and *C*) or a keyhole or a Gigli saw is sometimes used to divide bones, but the saw produces bone dust and is more liable to injure the tissues than the sharper instrument, the osteotome or bone knife. *Osteoclasis* is elsewhere described (p. 306).

SCURVY RICKETS OR INFANTILE SCORBUTUS.

This disease is found even in nursing babies and is another evidence of malnutrition dependent upon improper food and sanitation, and aside from the usual symptoms of rickets, is characterized by hemorrhages into the joints or beneath the periosteum and into the marrow or mucous membranes. Sometimes the epiphysis is separated and very sensitive. The oozing of blood from the spongy gums stains the pillow nightly, but may be lessened by the administration of one or more drops of oil of erigeron canadensis on a lump of sugar three times a day, and by painting the gums with adrenalin solution. This soreness, tenderness, swollen joints, bleeding gums and general malnutrition serve to diagnose the condition from rickets, ostitis, and spinal disease.

Treatment.—Proper feeding, sunlight and fresh air are all-important. Treatment of course is not surgical but medical, along the lines indicated for rickets (p. 288).

KNOCK-KNEE.

Synonyms: In-knee; genu valgum; genu introrsum; scissor knee.

In-knee is the most common form of rickety deformity and is often accompanied by VALGIC FLAT-FOOT. The genu valgum rhachiticum should be differentiated from the genu valgum adolescentium or staticum. In many cases there is relaxation of the internal lateral ligament with shortening of the external ligament and fascia and sometimes of the biceps tendon. Deviation may also occur from an injury to the outer condyle interfering with growth, (Fig. 232) or from epiphysitis or osteomyelitis. The attitude of the patient is one of feebleness and the continual strain upon the internal ligament of knee and the valgic ankle, interferes seriously with locomotion. When the leg is flexed upon the thigh the disparity

FIG. 232.—Injury of epiphysis of external condyle of femur interfering with growth and resulting in elongation of inner condyle with marked in-knee.

FIG. 233.—Knock-knee on right side resulting in shortening of leg and tilting of pelvis; also flat-foot.

in the length of the condyles is less apparent and the in-knee almost disappears. When the deformity is limited to one knee (Fig. 233) the limping is marked and lateral curvature of the spine may result.

The differences in the conformation of the femur and the tibia at the knee-joint are well illustrated in the accompanying illustration from a patient of the author's (Fig. 234), and by Böhm, who gives the drawings of these bones both in man and in the apes.[1]

Etiology.—Knock-knee is caused in feeble children in an endeavor to support the weight of the body by bracing the knees against each other and widening the base at the feet. In adolescents, heavy weight-bearing or standing occupation is a common cause, especially in late rickets. In-

[1] Zeitschrift f. Orth. Chir., Band xx.

knee on one side and out-knee on the other in young children is caused by faulty carrying in arms while the bones are soft (Fig. 235).

A similar deformity of the knee resulting from infantile paralysis with contraction of the biceps seriously interferes with the walking gait of the patient, owing to the effort of swinging one knee past its fellow, and is particularly awkward and rocking.

FIG. 234.—Moderate elongation of inner condyle, and knock-knee. Epiphyses still ununited.

In some cases the upper extremity of the tibia may develop an irregularity in growth of the epiphysis, while in other cases the sharp bend may be in the upper portion of the tibia, as will be seen in the accompanying skiagram (Fig. 237); this may or may not be accompanied by an anterior or outward curve in the femur, or by a long anterior curve. Traumatism of either condyle of the femur may so interfere with epiphyseal growth that the knee will be bent inward or outward (Fig. 236).

Diagnosis.—The limp in unilateral cases and the waddling gait in bilateral knock-knee or bow-legs should always lead to a thorough clinical and X-ray examination of the naked child. Congenital dislocation at the

FIG. 235.—In-knee of right leg; out-knee of left, from faulty carrying in infancy.

FIG. 236.—Epiphyseal ends rudimentary, resulting in knock-knee.

FIG. 237.—Knock-knee with marked angularity of tibia and fibula below the joint cured by double osteotomies.

ara may exist with lateral curvature of the spine. The patient amined standing and lying, not sitting. Every patient with ld be examined for knock-knee.

s.—The tendency of in-knee is toward an increase of the m weight-bearing upon the shortened outer condyle. It is ifficult to cure in-knee with apparatus than out-knee and bow- e knee is held stiffly in extension, as the slightest flexion of he patient relaxes pressure and the apparatus becomes useless. the surer and speedier cure.

—The simplest record of the deformity for filing purposes is cing the child upon its back on a piece of oiled paper. With right angle to the paper and with knees one-fourth of an inch es directly upward, the outline is drawn from perineum to ard to the trochanter; or a lead strip tracing may be taken.

lative straightening of knock-knee by outward pressure at knee and inward pressure at ankle (Hoffa).

nt.—(1) Prevention; (2) manual straightening, gradual; (3) ppliances; (4) forcible immediate straightening and epiphy- perative measures, (a) osteotomy, (b) saw; (c) osteoclasis.

ENTION.—Constitutional and hygienic measures, as recom- ickets (p. 288), must be persistently employed. Fresh air and g are the most important elements.

dvisable to use the term EXPECTANT TREATMENT, since both to the professional mind it might lead to the LET ALONE policy. he softening and softened stage of bone rickets the most im- nt in treatment is the prevention of deformity which is almost ur if the child is allowed to walk, since bendings of the knees, will almost certainly follow (Fig. 237).

AL STRAIGHTENING, GRADUAL.—Much can be accomplished straightening of the bones whenever the slightest degree occurs. Decided benefit can be obtained by strong and firm against the inner condyle, while the lower part of the leg in the other hand (Fig. 238). The knee must not be allowed to

flex; and as much intermittent pressure may be exerted with reasonable comfort by the child. This should be don three or four times a day. After a few days, a greater am be daily exerted and massage and oil friction applied. In older children, bicycle riding, horseback riding astride, and walking should be encouraged after the bones are fairly well consolidated. Sloping soles help in preventing coexisting flat-foot.

3. MECHANICAL TREATMENT.—Gradual manual straightening by forcible pressure may be supplemented by progressive fixation with gypsum, or a cast can be applied to thigh and leg, then divided opposite the knee and the two sections jointed with metal strip opposite the internal condyle or in front and behind. Insertions of pieces of cork, gradually increasing in size, opposite the outer condyle will continually coax the knee outward, as in the Wolff method, or the outward pull may be made by the Mikulicz method (Fig. 239).

FIG. 239.—M od of correctin the thigh and being hinged, an attached to inn paratus.

Anzoletti proposes to apply a tight plaster bandage to the limb for two or three w encourage atrophy of the muscles, cl that at the end of the time the wa muscles will not resist correction.[1] softened bones can then be bent to proper form and a straight cast applied and the child encouraged to walk with crutches. His claim that the bones will bear the weight of the body in ten days without danger is at least problematical.

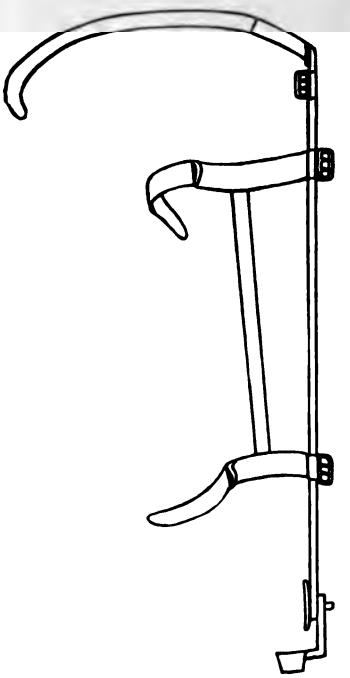


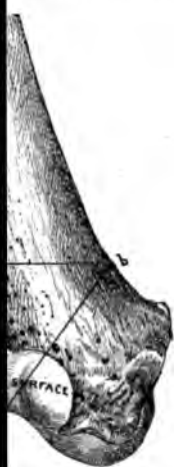
FIG. 240.—Knock-knee brace (Bradford and Lovett).

To be effective, a brace for in-knee must be without joint at the knee and must enclose the pelvis, while the knee is forcibly drawn toward the external upright, or pushed outward by a pad if two uprights are used. In the Thomas brace, the knee is fixed by a posterior bar, attached to two semicircular bands, and power is applied with a bandage. In double knock-knee, the position of the feet can be regulated, as in the Bradford brace, by lengthening or shortening the posterior pelvic strap attached to the curved arm of the appliance (Fig. 240). The upright may be bent outward from time to time as improvement occurs. The child will soon learn to handle these stiff-

[1] Amer. Jour. Orth. Surg., Nov., 1909, 269.

s with remarkable facility. If a steel pad is placed opposite r, the brace may be made more comfortable for sitting by he hip. If a spring brace is applied the pad should be knee while the straps encircle thigh and leg. If a brace with ights is made to extend only to the perineum, the three d pressure must be at the inner condyle, the trochanter, nal malleolus. If braces are worn at night the cure will be the deformity only affects one knee, locomotion will be er by raising the sole of the other foot so that the two legs length. This treatment by apparatus may be tried for six ear, provided the case is not becoming rapidly worse. If no is secured, an operation will become necessary.

BLE IMMEDIATE STRAIGHTENING UNDER ETHER; FORCIBLE IS; REDRESSMENT BRUSQUE OR BRISEMENT FORCÉ.—In young children with parents too careless to make manipulation effective or too poor to procure a splint, an in-knee can be cautiously corrected under anesthesia over a fulcrum, by a strong and careful surgeon. One hand grasps the thigh, the other the leg, and the limb is straightened and fixed in a slightly overcorrected position by plaster of Paris. The danger here, as in osteoclasis, is injury to the epiphyseal junction.



ewen osteotomy. *a*, condyloid osteotomy line of femur; *b*, section of inner condyloid fragment to ut this operation in- nt.

Forcible epiphysiolysis is sometimes applied to young children and adolescents but is vastly inferior to osteotomy. Forcible tearing of the femoral epiphysis or tearing the external lateral ligament by the sudden application of the surgeon's weight over the edge of the table or in a vise (the long lever being supplied by the patient's tibia and fibula), is injudicious, as subsequent epiphyseal growth may be made irregular, and deformity result. After six weeks the operation is repeated. After thigh and leg are enveloped in separate plaster casts con- t and behind with metal strips joined to work laterally.

ATIVE MEASURES.—(*a*) Osteotomy: (1) simple, (2) cuneiform; y saw; (*c*) osteoclasis.

acondyloid osteotomy of the femur (Macewen) is the simplest, st speedy method of correcting in-knee.

e or Linear Osteotomy.—The osteotome is a bone knife (Fig. It should be sharp and its cutting face the apex of two isosceles triangle, without any form of shoulder as is the case el. In other words, it should be like the blade of a knife, so may be quickly cut and not splintered. While theoretically e produces a compound fracture it practically does nothing of e if thorough asepsis of surgeon, patient and dressings have

been secured, the slight wound will heal at once and the case becomes one of simple fracture. The operation is one of the safest and surest in surgery. Suppuration should never occur. An Esmarch bandage or tourniquet is undesirable as the outflowing blood is of advantage in preventing the ingress of air. If the osteotome is very sharp, or if a small narrow osteotome is used no incision will be necessary. In other cases a scalpel is carried directly down to the bone, the osteotome being inserted along its side.[1] Such puncture should only be sufficient to admit the instrument. The best point of entrance is one-quarter of an inch above the tubercle of the internal condyle, to avoid the articular artery and anastomotica magna, (Fig. 241, p. 296). The narrow subcutaneous Vance osteotome is sometimes

FIG. 242.—Deformities of legs shown corrected in Fig. 243.

FIG. 243.—Result of multiple osteotomies of thighs and legs in patient, Fig. 242.

used but its employment prolongs the time of weakening of the bone. The wider Macewen instrument is speedier and can be held and directed more accurately. If wide osteotomes are used, one of them should be wider and thicker than the other, the second being used in the deep portion of the wound. The osteotome is prevented from becoming fastened in the bone by a slight lateral movement, care being taken not to move it upon the flat, lest the edge be broken off within the bone. The surgeon should measure with his eye and fingers the diameter of the femur, that after the cancellous tissue has been passed, the mallet may be used with light taps to avoid a plunge through the far wall. The osteotome should be marked in inches. The sense of resistance and the sound of the stroke of the mallet will inform the surgeon when the distal layer of hardened bone has been reached. The knee should be supported upon its outer or its inner face upon a hard

[1] Willard, Osteotomy, Jour. Amer. Med. Assoc., xxxiii, 1057; Internat. Clinics, vol. iii, Series iv, 120; Tr. Amer. Orth. Assoc., vii, 180; Univ. Med. Mag., Phil., vi, 673; Archiv., Paediatrics, xii, 721.

sandbag as an anvil. The osteotome should be partially withdrawn and sufficient cuts (in adolescents) made through the bone to permit manual greenstick fracture of the remaining portion by a sharp sudden application of force over the sandbag fulcrum. Care should be taken not to perforate the posterior wall with the corner of the osteotome lest the popliteal vessels be wounded. After fracture, great care must be taken that the fragments do not become displaced, and if both legs are being operated, a stiff splint with temporary aseptic dressing is at once applied to prevent such an accident during the manipulations upon the other leg. The limb should be thoroughly OVERCORRECTED. In some cases where the deformity is very great, the contracted biceps tendon and fascia lata will require tenotomy. There will be considerable oozing from the bone but if both limbs are oper-

FIG. 244.—Supporting apparatus to be worn to prevent relapse after operation when ligaments and muscles are relaxed.

FIG. 245.—Result of osteotomies for double in-knee and curved tibiæ.

ated, it usually ceases during the manipulation of the second. If an incision has been made it should be sutured with absorbable gut, as the wound will not be dressed for six weeks. A thoroughly sterile dressing is applied, over which should be placed a thin layer of cotton and a flannel bandage. The surgeon then holds the knee in the overcorrected position to produce a SLIGHT OUT-KNEE, and the gypsum bandage is applied by an assistant, FIRST over the knee and for SIX INCHES ABOVE AND BELOW THE FRACTURE, while the limb is rigidly held by the surgeon in overcorrection. The cast is completed by applying the pelvic, thigh, lower leg and foot portions, which are less important; by this method greater accuracy of adaptation will be secured. An inserted zinc strip will permit cutting of the cast before it is thoroughly hardened and allow for expansion (p. 244). The cast should be worn for six weeks until complete consolidation is effected, after which the patient can run about upon it. In the majority of cases, especially if there is marked relaxation of the lateral ligament, it is best to wear a supporting brace (Fig. 244) for six months or a year,

while massage, gymnastics, muscular exercises, etc., are being applied. When one limb is operated and the patient is quiet, the cast may extend only to the perineum, but in restless children with double operation, it is advisable to enclose the pelvis, since with double fracture of the femurs, rotation or displacement readily occurs. When this long cast is being applied the patient should always lie on a pelvic dressing stool (Fig. 448, p. 494) to avoid motion and injury to the cast. The patient can be out of bed in a rolling chair in a few days, but it is undesirable to send reckless boys from the hospital unless necessary. Where there is an additional sharp curve in the upper portion of the tibia, as seen in Fig. 237, p. 293, a second osteotomy may be performed at the same time, but great caution

FIG. 246.—Result of osteotomies for double knock-knee.

FIG. 247.—Result after supracondyloid osteotomy in right leg of Fig. 248.

FIG. 248.—Knock-knee on right side corrected by osteotomy, see Fig. 247.

must be observed in the dressing that no rotation of the various fragments occurs. This may be prevented by enclosing the pelvis. Fig. 243, p. 297, shows the results of multiple osteotomies of thigh and legs.

Even if the cast becomes stained with blood it need not be removed, as the plaster itself seems to exert a powerful influence in preventing decomposition and the dressings will remain aseptic.

A few illustrations of the benefits of osteotomies are shown in Figs. 245 to 248.

These cases were of severe grade, but were quickly cured by linear femoral osteotomy, thus avoiding the long period of treatment by apparatus.

RECURRENCE OF DEFORMITY.—If the bone is still soft and ligaments relaxed, recurrence is apt to take place unless the cast is long continued or supporting apparatus supplied for six or more months.

2. *Cuneiform Osteotomy.*—Cuneiform or wedge-shaped osteotomy of the femur has been practically abandoned for the safer and simpler linear osteotomy.

(*b*) *Division by Saw.*—Section of the internal condyle by a blunt-pointed saw as performed by Ogston (Fig. 241), with subsequent sliding of

the fragment upward, seriously injures the knee-joint and has been entirely superseded by supracondyloid osteotomy.

(*c*) *Osteoclasis.*—Instrumental fracture. The osteoclast is a favorite instrument with some surgeons [1] but produces more injury to the soft tissues than the sharp osteotome. Undue strain is also put upon the epiphysis and the point of fracture cannot be as accurately fixed as in osteotomy.

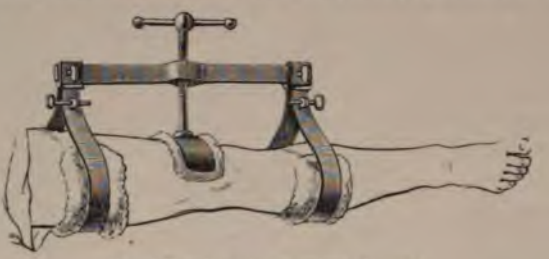


FIG. 249.—Rizzoli osteoclast (Young).

FIG. 250.—Grattan osteoclast.

FIG. 251.—Cork-screw deformities of legs, arms, clavicle and trunk. Lateral curvature of spine.

The bending and molding of the deformity is also better accomplished by the hands of the surgeon after fracture by osteotomy. The clean smooth cut of an osteotome heals at once and the fracture becomes a simple one and there is no injury to the tissues if asepsis has been carefully applied. In osteoclasis of the knee the ligaments and the epiphysis are subjected to great strain or separation, and injuries of the peroneal nerve with paralysis have been reported. This should never occur in osteotomy. Stiff knees and abscess have followed osteoclasis.

Various osteoclasts have been devised, but the patterns of Rizzoli (Fig. 249) or Grattan (Fig. 250), or Colin are the best.

[1] Blanchard, Trans. Amer. Orth. Assoc., 1900, 123, and 1901, p. 153.

Osteokampsis, or bending of a bone, is obtained by manual force over a wooden narrow fulcrum (Bowed Legs, p. 305), or by an osteoclast.

Excision and *arthrodesis* will not be required except in serious paralytic knock-knee. In traumatic cases with injury to the epiphysis of one condyle, the uneven growth may require a second osteotomy at sixteen years.

Multiple osteotomies are frequently necessary when both thighs and legs are deformed. If the child is in good condition it is better to perform a number of these sections at one time rather than to subject him to a series of operations, even if six or eight bones must be divided.

If osteotomy of the leg is combined with a similar operation in the thigh, caution must be taken in the dressing that rotation of the middle fragment does not occur; an unfortunate accident which would either turn the toes in the wrong direction or alter the relation of the head of the femur to the acetabulum.

The ANTERIOR and OUTWARD CURVE of the FEMUR, so often associated with bow-legs or with knock-knee, need not be sectioned unless the deformity is great. In the majority of cases of cork-screw degree (Fig. 251) it is wiser to first divide the tibia and fibula and the condyle of the femur, and later watch the powers of locomotion before performing a second operation.

GENU EXTRORSUM or OUT-KNEE is discussed with Bowed Legs, p. 304.

BACK-KNEE, GENU RECURVATUM OR RETRORSUM.—This deformity is the result of paralysis or weakness of the quadriceps, either congenital or acquired, or of club-foot. (Fig. 492, p. 545).

BOWED LEGS AND OUT-KNEE.

Synonyms: Genu varum; genu extrorsum; bandy-legs.

Curvatures in the lower leg are caused by the attempts of the rickety child to walk before the bones have sclerosed (Fig. 252).

FIG. 252.—Out-knee and bow-legs resulting from too early walking while rickety bones were soft.

Out-knee is twice as common as knock-knee in early childhood, while knock-knee may be developed later in adolescents. Anterolateral bowing of the legs is frequently caused by the sitting posture of the rickety child with legs crossed. A general outbowing of both tibia and femur may be further induced by the use of very thick diapers. Nearly all children beginning to walk spread the feet widely in order to secure a better base of support and weight-bearing in this position during the softened stage of rhachitis is sufficient to account for the outbowing. Out-knee on one side and in-knee on the other (Fig. 253) is not uncommon. Later, tricycle riding and horseback exercise may induce the deformity.

The patient should be examined entirely nude, both standing and lying, with knees both extended and flexed and with feet directed forward; otherwise, rotation of the legs or thighs may be misleading. Care must

FIG. 253.—Out-knee on left side; in-knee on right.

FIG. 254.—Curvature in thighs slight, the deformity in lower legs becoming apparent as soon as thighs are placed parallel.

FIG. 255.—Marked curvatures in femurs and tibiæ. Later straightened by osteotomies.

be taken to distinguish as to the portion of the leg in which the greater deformity exists, especially when there is great relaxation of ligaments. When the thighs are brought parallel, the method of leg crossing (Fig. 254) often demonstrates that the deformity is entirely below the knee.

Tracings.—For recording and reference, a tracing of the deformity is made by placing the patient flat upon the back upon a sheet of oiled paper, and outlining the legs with pencil (p. 294).

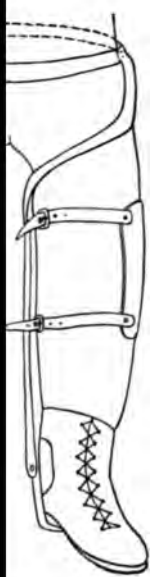
In out-knee the result of rickets, the sacrum is usually thrown forward, the pelvis rotated and the curved thighs (Fig. 255) cause the centre of

Fig. 256.—Curve of femur.

gravity to fall inside the centre of the knee-joint, the strain thus being thrown upon the external lateral ligament (Fig. 256). The inner condyle is compressed, the outer elongated.

Prognosis.—Small and moderate outward curves can undoubtedly be straightened by apparatus if continued until the stage of hardening is thoroughly reached. In extreme cases of bow-legs with out-knee, especially in those cases where the bend in the leg is sharply defined below the tubercle of the tibia, a favorable result is rare. In anterior curvature of the tibia no improvement can be expected from the use of apparatus, since the soft tissues and the sharp edge of the tibia will not bear pressure, and osteotomy becomes necessary. If it is true that one in five or six adult males is bow-

the fact that spontaneous cure takes place does not seem to be since in childhood under healthful conditions the proportion l children will not be any greater than one in five or six. Hospital results are necessarily inaccurate, since it is rarely that a bow-legged young child can be followed to adult life. The improvement in appearance is often due to the increased length of the bone in advancing years, but with only apparent lessening of the curve. In severe deformities after four years of age, apparatus is of but little use and operation is advisable. In adolescents and adults mechanical appliances are of small service and osteotomy should be done.



nee and bow-leg
d and Lovett).

Treatment.—Anti-rhachitic measures should be persistently employed, particularly fresh air and good food. All the measures recommended for rickets and knock-knee are applicable also to bow-legs (p. 288).

MANIPULATION, MASSAGE, AND FORCIBLE STRAIGHTENING should be commenced as soon as the tendency to deformity is discovered. Many times daily, gentle straightening should be done by making pressure upon the apex of the outward curve, while counterpressure is made at the inner malleolus. When the bones are still springy much benefit can be obtained.

ICAL APPLIANCES. — In *out-knee* ssure can only be secured by fixing th a stiff splint extending to the or to the pelvis. The point of ard should be opposite the knee, opposing pads being placed at the and inner thigh. The apparatus ched to the shoe either by stirrup, th extending into the heel, or by e worn within the shoe.

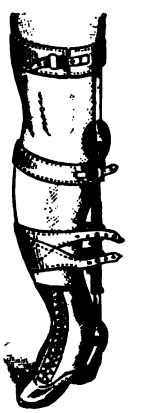


FIG. 258.—Bow-leg brace with single upright (Lents).

form of apparatus is shown in he position of the curved pelvic regulated by a posterior strap. *legs,* unaccompanied by out-knee, is need not extend above the upper pparatus is applied to both legs nching of the scrotum must be inst. In bowing below the knee, e pads should be opposite the internal malleolus and the dyle of the femur, while the fulcrum pad should be at a te the greatest point of curvature in the lower leg (Fig. 258). uprights are used, the improvement gained can be continued

by bending the apparatus to a straighter line each month, or by lengthening the inner upright frequently at the screw holes.

Operative Treatment.—FORCIBLE IMMEDIATE STRAIGHTENING.—(*a*) By hands; (*b*) by osteoclast.

(*a*) *Manual.*—In children under three years of age, especially where the lack of intelligence or the impoverished condition of the parents renders needed attention improbable, straightening can be effected by a strong surgeon placing the apex of the curve on the fibular side, upon a wooden block of triangular form (Fig. 619, p. 680). By a sudden quick, strong

FIG. 259.—Greenstick fracture of tibiæ—produced by sudden forcible hand pressure over wooden block—seen through plaster casts.

movement, guarding the epiphysis at the malleolus with one hand and the upper tibia with the other, a GREENSTICK FRACTURE is readily produced and the limb at once overcorrected (Fig. 259). A sand-bag or hard bandage is too yielding for a fulcrum. Failure to fracture occurs more frequently from timidity than from lack of strength. A plaster-of-Paris encasement should be at once applied, maintaining the slightly overcorrected position for four weeks, after which the child can walk upon the cast for two weeks more. Under the above circumstances this is the quickest and most certain form of relief. The bones heal as in a simple fracture. This method and osteoclasis are best applicable to long curves involving the entire length of the bone. When the curve is sharp and near the knee or ankle, osteotomy is safer and secures a definite point of fracture.

(*b*) *Osteoclasis.*—In older children a similar greenstick fracture and over-straightening may be accomplished by the osteoclast (Grattan or Rizzoli, Fig. 250, p. 300). The more rapid the action of the osteoclast the shorter time will the soft tissues be subjected to pressure and its consequences. As soon as the tibia snaps, the correction can be completed by manual power. Care must be taken in arranging the osteoclast that the epiphyses are not injured.

Fig. 260.—Result of osteotomies of tibiæ and fibulæ for bow-legs.

Osteotomy. — Linear osteotomy is the operation of choice in angular and severe outbowings where apparatus has failed to cure by the time the child has reached the age of three years, and also in all cases of anterior curvature of the tibia.[1]

The results of osteotomy are shown in Figs. 260 and 261. The bowing before operation was severe.

The technic of the operation has been fully described and need not be repeated (p. 296).

Fig. 261.—Legs osteotomized for double bow-legs.

The bone section is made at the point of greatest deformity. If the section is high up near the tubercle of the tibia, care should be taken to avoid wounding the anterior tibial artery. Should the posterior tibial be injured by a too free section of the rear tibial wall, the artery should be exposed and sutured or tied. The tibia is first divided and in adolescents the fibula is also cut through. A greenstick fracture is then produced by sudden bending over a wooden fulcrum. Slight overcorrection should be the rule. The wound will require only a single catgut stitch. To ensure accuracy of reduction before the application of dressings the surgeon should stand in line with the leg to note particularly the exact

[1] Willard, Article on Bowed Legs, Ashhurst's Internat. Encyclop. of Surg., vii, 450.

re-position desired, while an assistant applies the gypsum bandage. This position should be maintained until the plaster-of-Paris has become firm. In the application of this dressing the fractured portion should first be thoroughly fixed, leaving foot and thigh until the end of the dressing; better rectification can thus be secured.[1] A very thin layer of cotton is sufficient to relieve any dangerous pressure upon prominent points, or a flannel bandage may be applied from toes to the upper thigh, a zinc strip being inserted so that the cast may be cut open in front before it is thoroughly hardened (p. 244). This permits spreading of the cast in case of pain and also easy removal at the end of treatment. If shrinkage of the limb occurs, the cast may be tightened by a bandage. Metal, binder's board, wood or other material may be employed as splints but are not equal to gypsum. If the operation has been thoroughly aseptic, the cast need not be opened until such time as the fracture is healed, from four to six weeks, dependent upon the solidity and vitality of the bone. In cases where the patient is unable to supply apparatus, the child may run about upon the cast for several weeks as a precaution against subsequent bending of the callus. If the curvature is a bad one and the bones not fully hardened, a supporting apparatus should be worn for six months.

FIG. 262.—Anterior bowing of legs, with feeble locomotion.

ANTERIOR CURVATURE OF THE TIBIA AND FIBULA.

Anterior curve is one of the common results of rickets. It may be of moderate degree, as seen in Fig. 262, or so extreme that the skin on the anterior part of the leg may rest near the dorsum of the foot, as in Fig. 263.

The tibia is often flattened, known as "sabre-shin," and the projecting edge is so thin and close to the skin that the pressure of apparatus cannot be borne without ulceration and a brace is useless.[2] A moderate degree of outcurving or knock-knee or flat-foot may coexist.

Treatment.—LINEAR OSTEOTOMY is indicated in all severe cases of anterior curvature. For technic see Knock-knee (p. 296). After both bones have been divided and the tendo-Achillis sectioned, when the deformity is sharply angular, extreme force over the sand-bag fulcrum may be necessary to bring the bones into a reasonably straight line. The corkscrew cases (Fig. 251) will require multiple osteotomies. Care should be taken in applying the force that the fragments are not displaced. The

[1] Willard, Osteotomy, Tr. Amer. Orth. Assoc., i, 138; Phila. Med. and Surg. Reporter, lx, 65.

[2] Gibney, Trans. Acad. Med., New York, 1886, xlv.

fractured portion must be dressed while the limb is held by the surgeon in the exact position desired, with slight over-correction, the ankle and knee and thigh portions of the plaster cast being dressed after the fractured region has been enclosed. By this maneuver a much more accurate adaptation of the fracture can be secured and finger indentations of the plaster avoided (p. 246). The results of linear osteotomies are seen in Figs. 264 and 265, taken from cases of severe bowing.

A WEDGE-SHAPED OR CUNEIFORM OSTEOTOMY is rarely necessary even in severe anterior curves of the tibia, since a straight position may be secured by tenotomy of the tendo-Achillis and strong forcible straightening of the bone after linear section. When a wedge-shaped section is removed from the bone, the injury to the soft parts and the dangers of infection are greatly increased. The V-shaped gap made in the posterior aspect of the bone by the straightening process in linear osteotomy is

FIG. 263.—Sharp anterior bowing of lower part of legs, seen corrected by osteotomies in Fig. 264.

FIG. 264.—Same patient as Fig. 263 after osteotomies.

readily filled with callus and the bone made just as strong as by the wedge-shaped operation. Only in angular malunion following fracture, is there any necessity for osseous suture. If out-knee or genu varum is associated with bow-leg, an additional osteotomy of the condyles of the femur may occasionally be necessary. The employment of support is advisable for six months (Fig. 266).

Summary of Treatment of Bowed Legs.—1. Lateral bowing of the legs during the soft and springy stages is to be corrected by manual rectification or by the use of apparatus. A long curved out-bowing accompanied by out-knee can be overcome by mechanical measures in young children. In anterior tibial curves, apparatus is useless.

2. Forcible manual fracture over a wooden fulcrum and the production of a greenstick fracture, especially in cases where the parents cannot or will not attend to the adjustment of apparatus, is the best operation for young children.

3. Osteoclasis is not as accurate as osteotomy and is accompanied by greater injury to the soft tissues and epiphyses.

4. Aseptic linear osteotomy gives uniformly good results without suppuration and is the operation of choice. Wedge-shaped osteotomy is rarely necessary even in anterior curves.

5. Plaster of Paris is the simplest and most effective material for securing accurate position and maintaining absolute fixation.

6. The Esmarch bandage is undesirable during operation.

FIG. 265.—Legs made straight by multiple osteotomies.

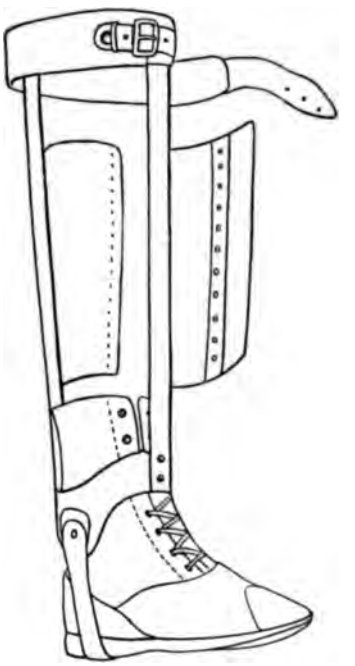


FIG. 266.—Support for anterior curve of lower leg. (Bradford and Lovett.)

COXA VARA.

The X-ray has disclosed many variations and irregularities of deformation of the head and neck of the femur and of the acetabulum which twenty years ago were faultily classified only as congenital dislocations of the hip.

Coxa vara is the name inappropriately applied to a misshapen condition of the upper end of the femur in which the head and neck are placed at a right or an acute angle to the shaft (Fig. 267, 3). In coxa valga the angle is obtuse (Fig. 267, 1). Coxa vara is usually the result of late rickets.

Not only may the neck be altered in its angle to the shaft, as in coxa vara adolescentium and in arthritis deformans coxa, but the head itself may be bent (Fig. 268) sharply upon the neck.

In children fracture of the neck or epiphyseal separation with union at an angle, from weight-bearing, may later slowly result in a position similar to coxa vara and be mistaken for it in later life; these are the cases of

TRAUMATIC COXA VARA. Motion is limited in one or more directions; limp and shortening occur and the pelvis is tilted. Congenital cases are rare.[1]

Two-thirds of the cases are found in adolescent males from occupational causes associated with late rickets, osteomalacia, infantile paralysis, epiphyseal disease or irregularity, traumatism or bone deposits. The deformity is also found in connection with cretinism, dwarfism, chondrodystrophia and osteogenesis imperfecta.

STATIC OR COXA VARA ADOLESCENTIUM is due to defective nutrition—LATE RICKETS—possibly to a tuberculous taint, with subsequent yielding of the neck even to a right angle.

FIG. 267.—1, angle of neck of femur with shaft in coxa valga; 2, normal angle; 3 angle in coxa vara.

FIG. 268.—Sharp bending of head of femur upon neck in late rickets.

Symptoms.—The condition is sometimes unilateral. Pain, muscular contraction, limping, shortening of the leg with outward rotation of the foot are the most prominent symptoms, with limitation of abduction, inward rotation and flexion. The trochanter is higher than normal. In bilateral cases the waddling gait, while resembling that of congenital dislocation, is accompanied by knock-knee or flat-foot, and lordosis is absent. Pain and tenderness may be local or transmitted down the thigh as low as the knee. Shortening of half an inch will produce a limp that will increase from tilting of the pelvis. Scoliosis if present will be due to the difference in the length of the limbs.

In extreme cases of deformity the head may approach the lesser trochanter and walking will be painful, as the trochanter and neck strike against the upper border of the acetabulum. The inability to abduct the thighs, in bilateral cases, will cause one knee in walking to be brought only up to the rear of the other. In extreme cases if the thigh is flexed to a right angle with the trunk, the foot will be carried across the opposite knee (Fig. 698, p. 748). A radiogram of the hip is always desirable in these cases and in addition to the clinical symptoms will assist in diagnosis.

[1] Feiss, Jour. Amer. Med. Assoc., Feb. 24, 1906, 565.

Diagnosis.—The shortening in coxa vara is noticed early; in tuberculous hip disease it comes late. The thickening about the joint, the fixation and flexion and finally suppuration are all present in hip disease. In coxa vara, motion is frequently limited only in abduction. Congenital dislocation of the hip will be disclosed by the X-ray. The distortions of the neck of the femur caused by prolonged sitting on the floor in flail legs from infantile paralysis, will be accompanied by other typical symptoms (p. 612), but slight cases of anterior poliomyelitis will sometimes be puzzling until the X-ray is used.

FIG. 269.—Coxa vara in boy of thirteen from excessive weight and late rickets. A linear osteotomy with fixation in abduction secured good locomotion.

Treatment.— If discovered early, weight-bearing should be prohibited. Extension in the horizontal line is useful. A walking perineal support and crutches are often of advantage (Fig. 424). Internally, antirhachitic or antisyphilitic remedies are to be used, while special benefit will be derived from sunshine, out-door life (Fig. 325, p. 381) and the avoidance of locomotion. Massage, gymnastic exercises and outward stretching should be persevered in for a long period of time.

In a case observed by the author, extreme obesity with late rickets was the evident cause; the boy at thirteen weighed two hundred pounds and his thigh was twenty-eight inches in circumference. As the neck yielded, the upper surface impinged upon the rim of the acetabulum, and the pelvis gradually tilted until it stood at an angle of 45 degrees with the median line, and extreme rotary lateral curvature of the spine resulted (Fig. 269). Abduction was impossible and all the movements at the hip were limited. In lying, when the pelvis was straightened, the foot was carried ten inches across its fellow and the lad could progress only on crutches. A linear intertrochanteric osteotomy and fixation in abducted position for eight weeks resulted in good locomotion without a cane and with limb in excellent position.

Operative Measures.—(1) Myotomy of the adductors with forcible abduction and retention by gypsum bandage for months; (2) linear osteotomy, subtrochanteric or at the neck just above the trochanters; (3) cuneiform osteotomy—a wedge-shaped section taken from the outer side of the femur below the trochanters (Fig. 270, *A*).

In FORCIBLE ABDUCTION, the power is applied to the shaft of the femur, the upper rim of the acetabulum being the fulcrum and the femoral head the weight.

In LINEAR OSTEOTOMY below the trochanter major, opposite the minor, the shaft of the bone is carried to abduction and the <-shaped gap upon

of the femur is allowed to fill with callus. In CUNEIFORM wedge-shaped section, >, one-half to three-fourths of an inch removed from the outer side opposite the lesser trochanter and surfaces are brought into apposition (Fig. 270, 2). In either should take the place of complete fracture and displacement voided.[1] A linear osteotomy involves less injury to soft tissues ge-shaped method. After any of these operations the femur d with plaster-of-Paris far out in the abducted position for eeks and union secured at such an angle that when the limb brought to the straight line with the body (Fig. 270, 3) the er and neck will not impinge upon the upper border of the

vara. 1, wedge of bone, *A*, re- e; 2, shaft abducted and fixed ion takes place; 3, restoration line after two months, brings rmal relation with acetabulum.

FIG. 271.—1, separation at epiphyseal line of head of femur; 2, restoration by forcibly abducting the femur, using the roof of acetabulum as fulcrum: 3, restoration of shaft to straight line after eight weeks of fixation in abduction. (After Whitman.)

The cast should of course include both trunk and limb. tment will consist in massage, active and passive gymnastic ipulations and movements.

c Coxa Vara from Fracture of the Neck or Epiphyseal Separa-

an has very ably called the attention of the profession to the he neck of the femur produced by fracture or by epiphyseal If undiagnosed, the fragment or the head becomes united to false angle similar to a coxa vara. After a severe traumatism h disability, such an accident should always be suspected and lied. Should a separation or fracture be discovered, it should eated by the forcible abduction of the femur under ether, pper border of the acetabulum as a fulcrum to bring the sep-

[1] oxa Vara, Univ. Med. Mag., July, 1900, xiii, 340.
Med. Record, July 25, 1893; Ann. of Surg., June, 1897; xxxi, 145; xxxvi, k Med. Jour., June 23, 1894; Jan. 21, 1899.

arated head into normal line with the neck (Fig. 271, 1). A gypsum bandage from thorax to foot, retaining the limb in the extreme abducted position (Fig. 271,2) for six or eight weeks, will secure union, after which massage and gymnastics will restore motion to the joint with the head in normal relation to the neck (Fig. 271, 3).

COXA VALGA OR COLLUM VALGUM.

Coxa valga is the designation given to an angle of the femoral head and neck with the shaft more or less obtuse than normal; in some cases reaching almost to a straight line [1] (Fig. 267, 1, p. 310).

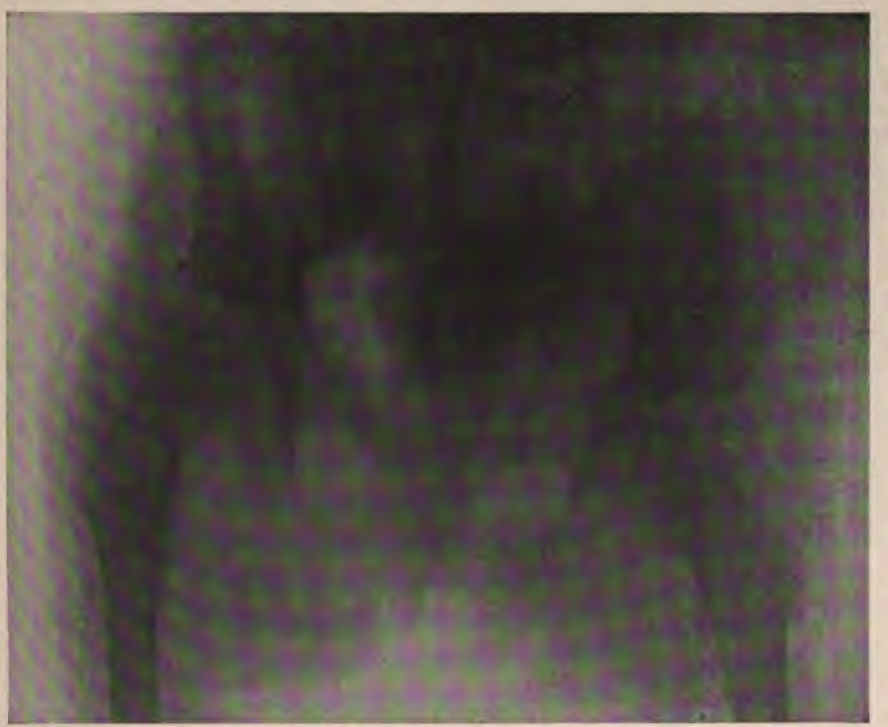


FIG. 272.—Coxa valga in paralytic who had never walked; neck of femur in nearly straight line with shaft.

Alsberg's rule for determining the relations of the neck and the shaft allows a deviation from the normal of 29 to 41 degrees. Below 29 degrees the angle verges toward coxa vara; above 50 degrees, the angle constitutes coxa valga. In Mikulicz's schedule the normal angle ranges from 110 to 135 degrees. Coxa valga or vara or other deviations of the neck may be the result of rickets, osteomalacia, pelvic bone disease, epiphyseal injuries before or after birth, arthritis, deposits about the joint, knock-knee, congenital dislocation or infantile paralysis. Valga is not commonly noticeable, a change of angle of 55 degrees seldom producing serious interference with locomotion. In paralytics the sitting position upon the floor

[1] Am. Jour. Orth. Surg., vol. iv, No. 3, p. 214.

dren, together with the absence of weight-bearing, often the angle (Fig. 272). In flail legs, superadded action of a psoas upon the lesser trochanter will add to the deformity, being toward valga. The altered position of the well leg in e locomotion in hip disease, will also account for distortion bone.

trochanter is flattened and is often below Nélaton's line Adduction is limited and the child is late in walking. The y, the patient in bilateral cases swaying the body from side is sometimes present, frequently absent. The leg is often ally or abducted. Slight scoliosis may be seen when one and the gluteals may be atrophied. The X-ray will confirm nptoms.

.—Fixation of a coxa valga in the position of exaggerated inward rotation even for a long period of time does not nuch help. Tenotomy of the abductors has been tried but l much improvement in function. In severe cases, a sub-teotomy with fixation in adduction will slightly benefit.

SYPHILIS, INHERITED.

syphilis may be HEREDITARY, transmitted from father or UIRED at birth by direct infection from a primary sore in he mother, or later from the nipple of the mother or from ntact with the infection. Older children may be inoculated h a diseased parent or by coming in contact with any soiled s may be infected through the sperm of the father without e mother, the latter becoming immune by absorption of ed by the child. In infection through the mother's ovum, e child is usually severe. If the mother becomes infected gnancy, vigorous antisyphilitic treatment of both father ust be instituted, with segregation of the husband. The treated an infant with SYPHILITIC SPONDYLITIS and secured sult, although the mother had been infected by her husband y months of pregnancy and treatment neglected.

syphilis may be transmitted by the father during either the ndary stage of his infection and occasionally in the tertiary he mother even many years after a tertiary attack.[1] The ild are often both infected by the father, but nearly 25 per mer escape, although by "choc en retour" the mother may s of the disease, maternal immunity being uncertain. A e sometimes escapes infection from a syphilitic child but healthy wet nurse is liable to be attacked. An apparently r may, however, later develop tertiary symptoms. A fetus either father or mother is likely to be aborted dead and iages may follow. After some years a fetus may be carried t will die early, and still later a healthy child may be pro- may be an alternation of healthy and syphilitic children.

[1] Knowles, New York Med. Jour., July 18, 1908.

The spermatozoids of the father during the primary stage of his infection are liable to infect both mother and child. Later the father will beget children with various forms of malnutrition. Naturally the mother is more likely than the father to transmit syphilis to the child as her influence is of long duration and of close intra-uterine and post-natal life. The mortality from abortions and from subsequent deaths reaches from 60 to 70 per cent. If the hereditary syphilitic survive, they may transmit the disease to a second generation, even though themselves free from personal infection.

Symptoms.—The symptoms in the infant, which may appear soon after birth, or even as late as six years, are usually those of the secondary stage. The mucous orifices at nose, mouth and anus are especially liable to patches; the child is marasmic, puny, pinched, feeble, irritable and with extremely faulty digestion and nutrition. The virulence of the symptoms will depend largely upon whether the mother has been properly treated during her pregnancy. Emaciation, together with lesions of skin or mucous membrane make their appearances, leaving coffee-colored stains. Scaly or bullous eruptions on palms of hands and feet, rhagades, fissures, anemia, notched teeth, interstitial keratitis, etc., may follow. Cranial thickenings are usually in the region of the anterior fontanelle. Bulging of the forehead is due to catarrh of the Schneiderian membrane that produces sniffles and later caries of the nasal bones with flattening of the nose. Craniotabes or thinned skull, bone lesions, epiphysitis, osteochondritis and osteophytic deposits sometimes appear early.

FIG. 273. — Tibial disease in hereditary syphilis.

The irregular ossification of the cartilage cells gives an uncertain ragged appearance to the epiphyseal line under the X-ray. Spontaneous separation only rarely occurs. If the periosteum is thickened about the epiphysis a distortion resembling dislocation or fracture may be simulated. In the shaft, the cortex or the endosteum is thickened partially obliterating the medullary canal. Gummata in the epiphyses simulate tuberculosis of the joint. Gummata in the marrow of the plalanges give spindle-shaped swellings similar to tuberculous spina ventosa (p. 569). Nodes on the periosteum of the shaft are not uncommon. The epiphyses may be completely destroyed or loosened by granulation tissue and yet recover under proper treatment with union and fair function. If mixed infection from other cocci occurs, the periosteum and bone become affected and suppuration and caries take place, or extensive osteomyelitis may necrose a large area of bone; the neighboring joint is usually involved early.

Periostitis and ostitis of the chronic type of thickening rarely appear in early life but may show from the fifth to the tenth year (Fig. 273). The most commonly involved bones are the tibia and the ulna. The thickened and forward curve of the tibia, resembling rickets, has received the name

. The swelling may be hard, gummatous or suppurative, ation of sequestra. Often several bones are affected.
symptoms appear in the first months of life. Local tender- nd swelling worse at night are evident at one or more epiphy- thickening and deformity. The indisposition of the child to os has given rise to the term SYPHILITIC PSEUDOPARALYSIS. ses may subside under treatment, the more severe ones go tion or osteomyelitis or death.[1] Congenital deformities of are common and the children of syphilitic parents are ne to develop feeble-mindedness, idiocy, cerebral spastic palsy and other nervous disorders.

A man must *always* pay dearly for lack of self-control, but with these frightful results before him it is strange that any rational man will, for a few moments of self-gratification, sacrifice not only his hope of future marital happiness, but also the life of his wife and children.

In congenital syphilis the first set of teeth will indicate faulty nutrition and defective blood supply to the teeth sacs, resulting in defective enamel with altered soft dentine and various irregularities of formation. The typical Hutchinson's teeth (Fig. 274) are the permanent central incisors which are notched crescentically and obliquely at their free borders. This notching differs from the roughening and defective enamel of early measles or other exanthems.

A

B

cteristic teeth of in- , upper permanent y notched; lateral in- ct; right canine has dentine has become incisors only recently tch marked out but by breaking away of ; four lower incisors rescences due to loss ure of dentine. (Pier-

Diagnosis.—As a rule the clinical symptoms and the speedy effect of antisyphilitic treatment are sufficient to establish the diagnosis between syphilis and TUBERCULOSIS. ubt, a differential serum-reaction diagnosis may be tried.[2] rought in contact with the specific antibody should give a plement. The reaction of hemolysis is the rendering trans- paque suspension of blood-corpuscles.
ermann diagnosis is not adapted to children.[3] It is as yet that the specific microbe is the *Spirochæta pallida, Tre-* ,[4] but this thin filiform spiral protozoon has been discovered cases of syphilis both in the new-born and in the fetus, in ion than in adults. The butyric acid reaction is sometimes hi). Lymphocytosis is common but is not diagnostic.
ing of the epiphysis in inherited syphilis comes on earlier

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ne Syphilis in Children, 1875.
. Woch., Berlin, Mar. 12, 1908, Bruch.
. Med. Assoc., Feb. 22, 1908, 609 and Nov. 16, 1907; Sept. 18, 1909, 936.
. Med. Assoc., Sept. 4, 1909, 757.

than in SCURVY. The latter does not appear until after malnutrition is in evidence for several months.

The diagnosis from bone or joint TUBERCULOSIS, infectious EPIPHYSITIS and OSTEOMYELITIS is sometimes difficult and will depend upon the presence of other syphilitic symptoms. Multiplicity of lesions point to syphilis; curved bones to rickets; hydrarthrosis and ankylosis rather to tuberculosis. Tuberculin tests (p. 375) and the inoculation of guinea-pigs will determine the diagnosis. Gummata in the vertebræ closely resemble spinal tuberculosis.

OSTEOMYELITIS will be recognized by the presence of pyogenic organisms; actinomycosis by the distinctive granules. The X-ray is valuable in showing thickening in cortex and irregularity of contour. The periosteum will be thickened and the medullary cavity indistinguishable.

Treatment. — The preventive treatment of inherited syphilis is of prime importance.

If the placenta of a suspected syphilitic mother can be demonstrated to contain syphilitic toxins, early treatment of the child after birth will prevent bone and joint invasions. The SERUM obtained from syphilized monkeys, if it is mixed with organic extracts, or the serum from syphilitic patients, and guinea-pig serum, may result in the production of helpful antibodies.

Every pregnant woman, if either her husband or herself is syphilitic, should be systematically and continuously given a mixed antisyphilitic treatment. The child should be protected during birth by potassium permanganate flushings of the vagina and the mopping of the vagina with 10 per cent. solution silver nitrate. The eyes should be cleansed immediately after birth and corrosive chloride solution 1:4000 instilled upon the conjunctiva to prevent the ophthalmia that leads to blindness. The importance of early treatment in this disease is so thoroughly recognized that Germany and Russia have special institutions for treating these infants.[1]

INUNCTIONS.—If syphilitic symptoms are evident, systematic treatment must be at once instituted. As hypodermics are undesirable for young children, mercurial ointment or calomel in lanolin may be employed by inunction, especially for congenital bone syphilis.

For an infant, unguentum hydrargyri, one-half strength, is applied upon the flannel binder for twelve hours each day until the constitutional signs of blue gums and fetid breath are noted. It should then be suspended for a few days but resumed at the end of a week, and reapplied every alternate week. MERCURIAL VASOGEN OR MERCURETTES may also be used. The mercurial ointment inunctions may be applied to the inner side of thighs and arms, and will readily yield the constitutional effect of the drug but must be carefully watched. Mercurial vapor baths also can be given to the skin or by inhalation. Rapid mercurialization is produced by *intravenous* injections of large doses of bichloride. The author has administered ¼ grain to a boy of seven years of age. In adolescents, hypodermics of salicylate of mercury are used.

As soon as the evidences of malnutrition and indigestion present themselves in an infant, internal medication is necessary. The author has found

[1] Deut. med. Woch., No. 19, 1906.

tual as doses of $\frac{1}{300}$ to $\frac{1}{500}$ grain of mercuric bichloride given of essence of pepsin, well diluted with sterile water after Under this treatment the fretful, emaciated, cachectic baby how signs of improvement. The treatment must be con- as any evidences of general or local bone and joint disease older children the protiodide or biniodide in appropriate substituted or Donovan's solution (liq. hydr. iod. et arsen.) op doses, alternated every other week with a fraction of a 's solution of arsenic. Syrup of the iodide of iron, one drop life, or the fraction of a grain of sodium iodide may be given. is important. The infant's skin is thoroughly rubbed each or codliver oil. Gray powder also can be used. The tonic ry employed as indicated, is most remarkable in bone and and induration and swelling will speedily lessen.[1] Iodine lied to the epiphyses. If mixed infection occurs, the bone l be treated as noted in Osteomyelitis (p. 597). In larger el suspended in olive oil or vaseline may be injected into the back or thigh once a week. The dose must be regulated he child, five to ten centigrams being sufficient for an adoles- odide or bichloride with bacterin therapy may be employed. —The prognosis is most distressing. The mortality reaches r cent. in the first two years, if mother and child are untreated t disease arises; but under proper care of both, this mortality reduced. The second children of syphilitic parents are less sease than the first, as the mother will probably have been her second pregnancy. An infected fetus is very frequently earlier children of a syphilitic father or mother are usually yphilitic man or woman with primary, secondary, or tertiary ld kiss a child. No syphilitic man or woman should marry rs of the infection, nor until after at least two years of abso- from any symptoms of the disease. Not infrequently the pear many years later, especially after an illness, and the us transmitted to offspring. If marriage has been most ntracted, continuous watching and treatment of both man essary, since children suffering and dying from hereditary but be a reproach and a horror to any decent man or woman. of primary disease acquired from direct infection in lewd horoughly described in treatises on venereal disease. Syphi- in children from kissing or contact of clothing is treated syphilitic principles.

RODYSTROPHIA FETALIS—ACHONDROPLASIA.

of the extremities caused by fetal defective growth of It is sometimes mistaken for congenital or fetal rickets, but l from rhachitis by the fact that all of its deformities exist e legs are always disproportionally short, the head is large, nd the sternum usually deformed (Fig. 275).

[1] Hunkin, Calif. State Jour. of Med., vi, 2.

Chondrodystrophia is a disease of the primordial bone cartilage due to a disturbance in the row formation of the proliferating cartilage cells. The pathological findings are similar to those described by Virchow in congenital cretinism and congenital rickets[1] but the condition is probably

FIG. 275.—Chondrodystrophia fetalis: legs shortened, abdomen prominent from lordosis of spine.

independent in its origin (Fig. 276). With the cessation of this row formation, further bone development becomes impossible and ossification occurs. Disturbance of the thymus secretion may account for this condition, as

[1] Nathan, Amer. Jour. Med. Sci., cxxvii, 690; Mueller, Wurzberger med. Zeitschrift, 1860.

thymectomized animals[1] show somewhat similar bone changes. The lower limbs are sometimes so shortened that the child can walk on his hands with his body horizontal, as in a case described by the author[2] (Fig. 700,

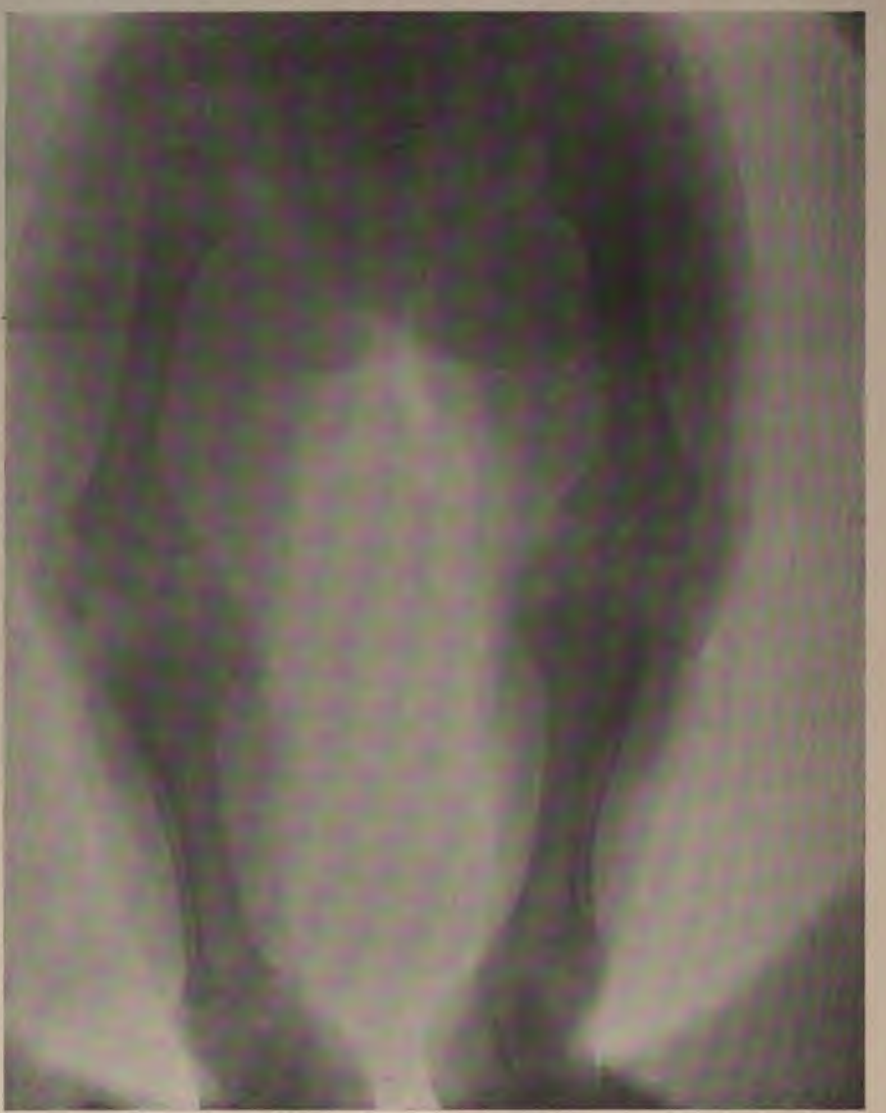

FIG. 276.—Thigh and leg bones of child, Fig. 275.

p. 749). The epiphyses are enlarged, which has caused the condition to be confounded with fetal rickets. The TREATMENT should be the same as for rickets (p. 289). Surgical measures may sometimes improve distortions after an X-ray has revealed the bony deficiencies.

[1] Amer. Jour. Orth. Surg., Oct., 1907, 240.
[2] Willard, Tr. Amer. Orthop. Assoc., 1904; Amer. Jour. Med. Sci., xi, 1904, 690.

The author has seen one case with only a trunk (fortunately born dead) in which both legs and both arms were entirely absent, the sites of the extremities being smooth and non-cicatricial.

Cretinism causes even greater dwarfism of the body and may be combined with chondrodystrophia. As a rule, mental deficiency coexists. The use of thyroid extract and bone marrow are helpful.[1]

Gigantism or macrosomia, and nanism or microsomia are rare.

OSTEOGENESIS IMPERFECTA—IDIOPATHIC FRAGILITAS.

This is a rare condition, the result of defective endosteal and periosteal osteoblasts in fetal life from unknown causes, sometimes hereditary. Death of the child before birth usually occurs.[2] The condition is akin to CHONDRODYSTROPHIA FETALIS but differs in its pathology.[3] It differs also from the asymmetry of CONGENITAL DEFICIENCY OF BONES, discussed elsewhere (p. 756).

The bones are fragile and are easily fractured but the disease differs from the FRAGILITAS OSSIUM of later life. The condition also varies from intra-uterine rickets, although formerly called FETAL RICKETS and INFANTILE OSTEOMALACIA. Looser[4] claims that the morbid anatomy of IDIOPATHIC OSTEOPSATHYROSIS—fragilitas ossium—is similar to that of osteogenesis imperfecta.

The children thus infected are usually small with short or deformed limbs. The skull is often soft and flexible, and the face may be cretinoid.

Treatment.—Great care in handling the child is important to protect against fracture. It should be kept upon a Bradford frame (p. 422) and especial attention given to hygienic and nutritional measures. Thyroid extract and bone marrow may be tried.

FRAGILITAS OSSIUM.

Synonym: Idiopathic osteopsathyrosis.

Extreme brittleness of bones occurs congenitally but may result later from various conditions. The author has treated various members of a family in whom 32 fractures have occurred and the condition is now being transmitted to the third generation. The causative accidents in these cases were usually trivial, the defect being apparently due to a transmitted syphilitic taint. All of the children were small, almost dwarfish, and their ages varied from two days to twenty years.[5]

Looser[6] claims that the morbid anatomy is the same as that found in osteogenesis imperfecta, but differing from osteomalacia. The condition may be trophic.

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[1] Boston Med. and Surg. Jour., June 25, 1908.

[2] Griffith, Amer. Jour. Med. Sci., vol. cxiii and cxxix, p. 1.

[3] Bannatyne, Path. and Hygiene of the Fetus, octavo; Michels, Virch. Arch. f. path. Anat., Band 173, Folge xvii, p. 1.

[4] Mitth. aus d. Grenzgebeiten d. Med. u. Chir., 1905, Bd. xv, Heft 1 and 2.

[5] Willard, Medical News, Phil., li, 734.

[6] Mitth. aus d. Grenzgebeiten d. Med. u. Chir., 1905, Bd. xv, Heft 1 and 2.

ife fragile bones are found in sarcoma and after bone or joint
t that should always be remembered in forcible operations
A twisting force is the one most liable to produce a fracture.
isually large, but the bones unite quickly but with deformity.
ptomatic form may be due to local bone conditions, osteo-
oma, rhachitis, scorbutus, bone cyst, tabes, syringomyelia or
is of unknown cause. The author has seen fracture of both
coma from simply catching the thumb in the sheet while
These fractures however united without unusual callus.

t. — Calcium, phosphorus, mercury, iodides, and thyroid
been found useful. Precautionary measures are most
The fractures are best treated with plaster-of-Paris dressings,
under fractures of individual bones.

STEOMALACIA INFANTILIS; MOLLITIES OSSIUM.

acia resembles rickets in the softening of bones from absorp-
eous salts and in deformity, but is an independent though
pathological process and is rarely seen in children, being an
lition. Its most serious results are from interference with
adolescents.

perimented on pregnant sheep by removal of one suprarenal
oduced symptoms of osteomalacia, with rarefaction of bones.

t.—Hygienic treatment is of supreme importance.
ases of osteomalacia occurring during pregnancy have been
ypodermic injections of adrenalin on the theory of diminution
otor power of the blood-vessels. Bone tenderness and pain,
alk, and sleeplessness, were relieved by the treatment. One
00 solution has been used twice daily.[1] Suprarenal extract
used.
is is essential to prevent deformity, and later osteotomy or
ny may become necessary.

OSTITIS DEFORMANS.

: Paget's disease; osteomalacia chronica hypertrophica deformans.

eformans is so especially a disease of late life that it need not
on in this treatise.
se is unknown. The process consists in a rarefying ostitis
on of the osseous cells, permitting a gradual bending of the
primarily in the femur and then extending to other bones.
lateral or bilateral.[2] The prognosis is unfavorable and treat-
ing.

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1. Amer. Orth. Surg., Jan., 1908, p. 368.
2. Reynolds and Andrus, Univ. of Penna. Med. Bulletin, Nov., 1904; Medicine, Jan.,

CRETINISM.

Total or partial absence or atrophy of the thyroid gland results in a condition of physical and mental degeneration akin to myxedema.

The disease is often hereditary and makes its appearance in the first or second year of life. The short stature, large hands and expression of face, with the wrinkled, thick skin are characteristic (Fig. 277). The condition is found most frequently in goitrous regions of country and in the children of goitrous or cretinous parents. Toxic agents from

FIG. 277.—Cretin, with feeble facies, large hands, and protruding abdomen. (Barr.)

FIG. 278.—Cretin, after one year's treatment with thyroid extract. (Barr.)

defective thyroid function of the mother undoubtedly affect the child in utero. The mental condition varies from slight feeble-mindedness to idiocy. The voice is hoarse, or the patient may be a deaf-mute or a dwarf.

Treatment.—Fresh thyroid or thyroid extract has accomplished marked results. Fig. 278 shows a cretin who in one year of thyroid treatment

improved so much that from being unable to speak a word, she acquired an excellent vocabulary.

CRANIECTOMY has not proved beneficial.

ACROMEGALY.

The relation of enlargement of the hypophysis cerebri to acromegaly, gigantism and adiposis, is still undetermined. Tumors in the anterior or posterior lobe of the pituitary body[1] produce a variety of symptoms yet to be classified.

Acromegaly rarely occurs under fifteen years of age. It consists in enlargement of the bones of the face, especially of the lower jaw, and of the

FIG. 279.—Acromegaly—enlargement of hands, feet, and jaw.

hands, feet and skull (Fig. 279). Sajous[2] has done most excellent work upon the relation of the pituitary body to the suprarenal glands and to the nutritional powers of the body. The enlargement of the pituitary body has led to the employment of pituitary extract or of thyroid or suprarenal extract for relief.

LEONTIASIS OSSIUM.

A condition akin to acromegaly consists of bony outgrowths (hyperostoses) of skull and upper jaw. These masses may fill the nasal cavity, antrum or orbit, producing intracranial pressure. The only surgical relief would be the chiselling away of the projecting masses if they are in position to be reached.

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[1] Cushing, Jour. Amer. Med. Assoc., 1909, Trans. Surg. Sec., 1909; McCarthy, Trans. Phil. Path. Soc., 1909, Apr., 171; Krumbhaar, Trans. Phil. Path. Soc., Apr. 1909.

[2] Sajous, Internal Secretions.

MYOSITIS OSSIFICANS PROGRESSIVA.

The deposit of bony material in the muscles, particularly those of the trunk, arms and neck, resembling multiple exostoses, may begin in early life. The extension of the process is marked by progressive disability. Accompanying developmental troubles as microdactylia would seem to point to a congenital fault. Traumatism can be traced as a cause in later life.

Traumatic myositis ossificans apparently originates in the deposition of periosteal cells, or from an actual piece of periosteum displaced into the muscles by the trauma.

Treatment has thus far failed to benefit the condition, but removal of superficial deposits gives relief.[1]

The deposition of osseous masses in the neighborhood of a joint following dislocation or traumatism, with progressive fixation of the joint, may give the surgeon much discomfort and anxiety lest a fracture has been overlooked.

RHEUMATISM.

Rheumatism is practically never seen in infants, the so-called cases being usually instances of ACUTE INFECTIOUS EPIPHYSITIS. Under five years of age the disease is extremely uncommon; in fact, every case of RIGIDITY AND PAIN IN A SINGLE JOINT IN A CHILD under ten should be looked upon as tuberculous unless it presents definite and distinct acute local symptoms of rheumatism (see Special Joints). Ninety-five per cent. of tuberculous joint diseases are treated for weeks or months under the false diagnosis of rheumatism when a five minutes' examination of the naked child would have saved years of suffering, pain, suppuration, bone destruction and deformity or death. Rheumatism in larger children is nearly always polyarticular and infects the smaller rather than the larger joints. In children over ten the symptoms will present the acute characteristics common in adults—abrupt onset, high fever, swelling, tenderness and acid sweatings. In some cases the condition seems to be a true infectious arthritis similar to the arthritis from scarlatina and other diseases. Special organisms, as the *Micrococcus rheumaticus* (Walker), *Diplococcus rheumaticus* (Poynton), *streptococcus* (Wasserman), have been demonstrated, but as observers differ the results are still undecided. Several investigators claim to have discovered as the specific germ, a bacillus that coagulates milk and which injected into a guinea-pig kills the animal in 24 hours.[2] Until the much-searched-for micro-organism of rheumatism is definitely discovered, the uric acid theory will be generally accepted.

True rheumatism, the result of purin excess of uric acid diathesis, is due to overproduction of uric acid from normal muscle metabolism and from cellular tissue destruction; from improper elimination by liver, kidneys, skin and intestines, and exogenously, from the ingestion of nucleins in the food. All of the avenues of ingress and egress must receive attention.

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[1] Jones, Archiv. Röntgen Ray and Allied Phenomena, Apr., 1905, Aug., 1906.

[2] Soc. Médicale des Hôpiteaux, Nov. 8, 1907.

uricacidemia the uric acid in the blood is in excess; in rheu-
lloid products are deposited in joints, muscles or tissues; in
sits are in crystalline form.[1]
sm in children is probably due to this faulty metabolism
the presence of a specific coccus. In some cases it is due to
eakness of tissue cells that furnishes a favorable soil for the
f any toxin, due to faulty metabolism or incomplete elimina-
Arthritis of plastic type is found in only about one-fourth of
umatism in children, but cardiac complications are common.
.—If the acids of proteid metabolism are the cause of the
nd other symptoms, a rational explanation is furnished of
lkalies and salicylates so frequently employed. As in tuber-
nefit of hygienic surroundings, air, food and sunlight, must
attention (p. 380).
t the production of uric acid by regulation of diet and by
vent its sudden precipitation in the joints as in rheumatism,
us precipitation as in gout, and to eliminate it through the
a, are all important measures (see paediatric treatises).
, with water in large quantities, is highly recommended as
the water being an important addition for flushing.
n suggested that the rheumatic poison is due to an insuffi-
oid secretion, and thyroid medication has been tested, but
not common in myxedema.
led "growing pains" are seldom rheumatic but are usually
e exercise or to osteomyelitis or some bone or joint trouble
yseal strains, which require that the child be stripped and
mined for some definite pathological condition (p. 596).

HEMOPHILIA.

d uncontrollable bleeding from slight wounds is an heredi-
occasionally seen in patients known as "bleeders." It is
mpanied by hemorrhage into joints, and is of especial inter-
. Its pathology is unknown except that it is due to a lack
y in the blood. Spontaneous hemorrhage is most frequent
ut may occur at any point from slight traumatisms, although
npanies menstruation or parturition. In joints, the synovial
ally presents a reddened, boggy appearance.
hilics, operation should be avoided, since hemorrhage into
ur following removal of loose bodies or other slight incisions.
place in childhood there may be no previous history of bleed-
or once lost a patient of eight years of age from this persist-
rollable oozing following a very slight operation on the knee.
ury, if the blood is allowed to remain in the joint—hemar-
ng, thickening and limitation of motion will persist and give
earance of tuberculous tissue, or may be mistaken for osteo-
X-ray will assist in showing the condition of cartilage and
or rickets may coexist. Slow, gradual pressure with a

[1] Wood, Therapeutics, 13th ed., 669, 863.

woven elastic bandage, or strapping with adhesive plaster, will assist in absorption. Even slight contusion of a joint in this dyscrasia may be followed by a large effusion of blood without any external wound—hemarthrosis. If this takes place slowly, it is not painful. Ice and a firm splint should be at once applied, with complete rest. If the diagnosis is established by the symptoms and X-ray, the joint should be injected with a 2 per cent. solution of formalin in sterile glycerin. On the third day it may be opened and all fluid and clots thoroughly washed out under most careful asepsis, forceps or a clean gloved finger being inserted to remove clots. If hemorrhage has entirely ceased, the wound may be at once closed. If there is still oozing, gauze drainage should be maintained for two or three days, the stitches inserted at the time of operation being tied loosely. In cases of defective nutrition there is danger of the clot becoming infected. Later, manual massage and voluntary and gymnastic movements are commenced.

Adrenalin injections of .0001 gramme together with closure and rest may prevent an otherwise fatal ending to an operation in hemophilics. Internally, oil of erigeron canadensis, ten drops on a lump of sugar three or four times a day preceding a necessary operation, may save a life when this diathesis is known to exist. After operation, if oozing occurs, this oil may be given every fifteen or thirty minutes, or as often as the stomach permits. Thyroid extract in three to five grain doses is useful, as is also calcium chloride and gelatine. Continued oozing following the extraction of a tooth should be treated by packing with adrenalin or alum and the internal administration of oil of erigeron canadensis. Calcium chloride in healthy blood serum may be injected.

Transfusion of Blood.—In a boy of twelve who had bled profusely from the teeth for four days and in whom the hemoglobin was but five, direct transfusion of blood from an adult checked the bleeding and in one month the hemoglobin registered 68 and the red cells 3,930,000. Later, he had a swollen knee-joint and the gums still oozed on slight provocation.[1]

[1] Allen, Annals of Surg., Oct., 1908, 625.

CHAPTER XI.

FRACTURES.

FRACTURES IN CHILDREN.

es not permit of the complete treatment of the large subject The discussion, therefore, will be limited to the lesions as found d especially to the points wherein conditions and treatment ults. The general subject of fractures is so widely treated works that undue discussion will be avoided as far as possible. ortant differences are evident at the outset. The occur- ren of INCOMPLETE OR GREENSTICK OR BENT OR WRINKLED secondly, the SEPARATION OF EPIPHYSES—EPIPHYSEAL DIS- m juxta-epiphyseal injury.

en also the existence of fragilitas ossium and rickets often erious aspects. In the softening bones of rickets, the excess ter renders them liable to bendings and distortions yet not fracture. During the transition stage of calcification and bones may give way readily, but after the hardening stage reached, they are not more readily broken than normal bones. ITARY SYPHILIS the bones are fragile. The author has had one family in which thirty-two fractures have occurred in ers and the daughters are now producing children with this n of brittleness[1] (p. 321).

lled SPONTANEOUS fractures occur from the fragility of osis or from constitutional conditions, plus a slight injury. ses require constitutional and hygienic treatment.

omy of the skeleton of children is of importance. The skel- ant still shows the peculiarities of fetal life, the lower limbs he pelvis small and the epiphyses widely separated from (Fig. 6, p. 7). By the age of ten years the lower limbs en and the excess of cushioning superficial fat has disappeared ve influence of motion. A child's bones are elastic and will reater proportionate amount of force than those of the adult, ing to the blow rather than breaking. In the skull a decided ay speedily resume its normal contour. The shorter distance d also protects the young child in its scores of daily falls. In n the care of parents or nurses in a measure protects them ccident, yet this is counterbalanced in uncared-for children, r the first ten years of life, by the large number of fractures ir inability to guard themselves from danger. From eight the recklessness of boys renders them especially liable to lls from heights or from moving objects.

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[1] Willard, Fragilitas Ossium, Phila. Med. News, li, 734.

There is marked discrepancy in statistics as to the region of the skeleton most liable to fracture in children. From cases treated at the Pennsylvania Hospital from 1830 to 1877,[1] in a series of 8667 fractures tabulated by the author, 44 per cent. were of the bones of the upper extremity; lower extremity 45 per cent.; head 6 per cent.; trunk 5 per cent. The age of greatest frequency was between thirty and forty. In children the most frequent fractures were in the forearm and leg. Fractures of the tibia and the fibula, or both, constituted 27 per cent. of the whole number in children and adults. The proportion of males to females was 5 to 1. No fractures of the patella occurred under 10 years. Of 885 fractures of the femur, 115 occurred in school children and 74 in "young children," a total of 189. The author's statistics give region of bone, age, amputations, deaths, variety and occupation. Many of the 8667 fractures were compound and comminuted, causing 1193 deaths, chiefly from "shock" or "pyemia"; 40 per cent. of skull fractures died. Of fracture of vertebræ, 56 per cent. died; of the pelvis, 38 per cent.; 12 of the latter were in children or adolescents. Of 5000 recent fractures, Ashhurst gives a mortality of 2.7 per cent. Packard,[2] Grunert and other statisticians give the forearm as the region most frequently broken in the first decade, while others place the femur first. Scannel's collection of 38,627 fractures at the Boston City Hospital[3] gives the radius as the bone most frequently broken.

Gurlt's tables[4] show that 76 per cent. of fractures under ten years of age involved the bones of the upper extremity and 24 per cent. the lower, while between the twentieth and thirtieth years the proportion was 60:40.

In the Children's Hospital, Philadelphia, counting both ward and dispensary patients, fractures of the forearm, clavicle and humerus stand in frequency in the order named.[5] In other tables, the femur is the bone most frequently broken, but these statistics may have been taken from in-patients, not from walking dispensary cases.

Epiphyseal Separation. — DISJUNCTION of the EPIPHYSIS from the diaphysis, with or without fracture of the neighboring condyle, is quite common after ten years of age, from traumatism. In the first decade the child is better guarded. The epiphyses of bones that receive their nutrient arteries in the direction toward the joint, become ossified earlier than those in which the blood supply is less abundant.[6] Separation at the epiphyses takes place easier in *rickets*, hereditary *syphilis* and *scurvy*. The line of separation often includes a portion of the neighboring bone. The centres of ossification in the epiphyses appear in different bones from birth to the age of eight (see Röntgenograms, p. 6, 7). The epiphyses unite with the diaphyses soon after puberty, the process being completed in females at about twenty years; in males, at twenty-five. The upper and lower ends of the humerus, the lower end of the femur and of the radius are the regions most frequently separated. Mobility, loss of power, pain, swelling, ecchymosis will be present, crepitus is masked even if present. Dislocation is rare.

[1] Agnew's Surgery, vol. i, 853-862, 2nd ed.
[2] Keating's Cycl. Dis. Chil., iii, 1046.
[3] Keen's Surg., ii, 57.
[4] Handbuch der Lehr. v. d. Knockenbrüchen, Bd. i, 13.
[5] Keating's Cycl. Dis. Chil., iii, 1046.
[6] Owen, Surg. Dis. Children, 1891, 381.

Reposition is easier in epiphyseal disjunction than in dislocation, but recurs easily. The X-ray is very important in diagnosis. Tearing off of an epiphysis or a fracture from MUSCULAR ACTION rarely occurs, but the former accident may be produced by reckless traction on the legs in head-last labors.

Indirect fractures, as of the clavicle or elbow by falls on the hand, frequently occur. DIRECT INJURIES from blows, moving objects, etc., may result in either simple, compound or comminuted fractures, or complete crushes. INTRA-UTERINE or intrapartum fractures sometimes occur from injury to the mother or from amniotic disease, and union may take place before birth, or pseudarthrosis may result (Fig. 280). PARTURITION fractures occur by undue violence during labor especially if a blunt hook

FIG. 280.—Ununited fractures of the leg bones from injury in a difficult labor. (Elmer.)

is used instead of the finger in making traction on a thigh or arm during impaction in the pelvis, or if strong force is used in making version. FRACTURE of the SKULL results from undue pressure of the obstetric forceps. Resultant intracranial hemorrhage is the frequent cause of cerebral spastic palsy and of imbecility, a fact that should be more frequently remembered by obstetricians.

Sprain Fractures.—The coexistence of a fracture, or the tearing off of a fragment, or the tearing out of bone particles with the periosteum in sprains, is a condition frequently overlooked by surgeons, with unfortunate results if treated as "only a sprain." The frequent occurrence of this complication, or of separation of an epiphysis at the malleoli of the ankle, or in the radius at the wrist, or of the femur above the knee, should lead the surgeon to administer an anesthetic in *every case of injury near a joint* where there is the slightest uncertainty as to diagnosis. The use of the X-ray and fluoroscope will greatly assist. If still uncertain, the case should

be treated as one of fracture, not of sprain. An incomplete separation of the epiphysis, improperly designated "juxta-epiphyseal sprain," is often maltreated (p. 360). Fractures in spite of every precaution will sometimes unite badly or not at all, and loss of function or ankylosis or deformity or non-development or infection or paralysis may follow. A wise surgeon, especially in fracture near a joint, will divide the responsibility by calling a consultant. Certainly since the advent of the attractive but illusive radiogram is this important, since a shadowgram exhibited to a jury may show marked deviation from a normal bone while its function may be perfect. Any one watching his own shadow on the ground in a strong sunlight or moonlight at different angles will note its absolute deceptiveness. A single shadowgram is very unreliable and in all cases the interpretation of the Röntgenogram is difficult, requiring anatomical knowledge both of dead and of living bones (p. 5, 6). Patients should be forewarned that an absolutely perfect apposition is the exception, although good functional results may be expected even when the ultimate X-ray delineation is somewhat imperfect. The risk of censure is so great that many excellent surgeons refuse absolutely to treat any fracture, and it is probable that these injuries will in the future be placed largely in the hands of skilled orthopaedic surgeons, since fractures require greater patience and longer and closer attention than is usually rendered by the ordinary surgeon in the rush of acute surgical work.

All infants and young children should be stripped after any severe accident. The majority of errors in diagnosis are due to insufficient examination. The presence or absence of all the ordinary symptoms of fracture should be carefully noted, loss of function, mobility, swelling, deformity and pain. A baby with fracture of the clavicle or femur may continue to use the limb and scream, not having sufficient experience to know that quietness of the part will relieve the pain.

Anesthesia.—It is often impossible in a fat infant or young child to detect a fracture without an anesthetic, since crepitus is frequently absent especially if the periosteum is intact or if greenstick fracture or an epiphyseal disjunction has taken place.

Compound Fracture.—Compound and comminuted fractures (Fig. 281) are usually the result of severe injuries and are treated with reference both to the wound and to the fracture. With the most thorough asepsis and antiseptic care and with reduction and fixation of the fragments, better results are to be expected in children than in adults. The recuperative powers of children are so great that no limb should be sacrificed by amputation unless it is doomed past all possible help. Most wonderful recoveries are often achieved by the surgeon who will carefully and scientifically treat and watch this class of cases.

Treatment.—The first and most important step in the treatment of a fracture is THOROUGH REDUCTION of the fragments. If this is accurately accomplished RETENTION is much less difficult, as the muscles are not likely to reproduce displacement. Reduction is usually best done under anesthesia with skilful manipulative traction and the help of the fluoroscope. As the fracture in children is often transverse, the fragments if once reduced will remain in position with but little support.

RETENTION.—Retention may be accomplished in various ways. In the treatment of fractures in childhood there is no dressing so satisfactory and efficient, in the large majority of cases, as plaster-of-Paris on account of its ready adaptability to any region of the body, its quick setting properties and its inexpensiveness. Unfortunately not one surgeon in ten is educated in using it to the best advantage. The objections urged against its use, that it may be too tight for the primary swelling and too loose for the subsequent muscle shrinkage, are due to the improper application, not to the plaster (for technic, see p. 244). For infants and young children it is indispensable. Even when applied to the hips it can be well cut away from the genitals while hardening, and coated with shellac. Absorbent cotton and rubber tissue can be packed about the anus. In small boys with infrequent erections, perforated thin rubber tissue may be slipped over the penis and retained in place by adhesive plaster or collodion. The rapid setting property of good gypsum renders it much better than silicate of sodium or potassium (liquid glass) or paraffin or glue or starch for fracture purposes, since, in order to "set" the bone, the material must "set" while the surgeon MAINTAINS THE REDUCTION that he has secured.

FIG. 281.—Compound comminuted fracture of femur.

The FRACTURED AREA MUST BE THE REGION FIRST DRESSED, since the hands of the surgeon can be employed in fixing, holding, extending and adapting the fragments in position. When the fragments have been secured, the upper and lower portions of the dressing, which are of less importance, can be completed. The limb having been dusted with stearate of zinc, a flannel bandage is applied firmly not tightly to the limb, or if contusion has been great and there is danger of undue swelling, the usual thin layer of absorbent cotton may be placed over the skin, the projecting osseous points being especially padded. A long strip of zinc or other metal wrapped in waxed paper, for easy removal, is then laid longitudinally upon the limb (Fig. 163, p. 244). The plaster bandages thoroughly wetted by placing them ON END under water until air bubbles cease, are wrapped snugly and smoothly about the limb by an assistant, avoiding wrinkles and finger pressures which result later in hard internal elevations. The surgeon must maintain his adjustment of the fragments until the plaster thoroughly sets. When the cast is sufficiently hardened, a sharp knife divides the plaster until the zinc

strip is detected along its entire length (Fig. 163, p. 244). The strip is then withdrawn and when the cast thoroughly hardens it can be sprung open as desired to allow for swelling, and, if of proper thickness, can be easily removed for inspection of limb and reapplication. By inserting a zinc strip in front and behind, or on both sides, the splint can be made in halves. If the surgeon prefers, he can use the original Bavarian plan of shaping double blankets, stitched posteriorly, coating them with creamy plaster and applying them to the sides of the limb (Fig. 282).

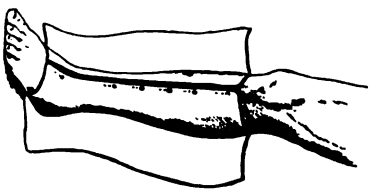


FIG. 282.—Bavarian dressing for fracture. The inner layers of blanket are applied to skin. The outer layers filled with plaster cream are applied closely to the limb and allowed to dry. (Agnew.)

The JOINTS ABOVE AND BELOW THE FRACTURE should both be fixed by the dressing; an important point in active children (Fig. 283).

A serious mistake in applying plaster is made by many surgeons by carrying the splint only a short distance above the knee or elbow, thus insecurely fixing the fragments if near the joint (Fig. 170, p. 249). The support should extend as near as possible to the axilla, or perineum, or may include the trunk.

A plaster cast applied as above indicated and divided AT ONCE, puts the surgeon in thorough control of swelling, permits inspection whenever necessary to watch circulation, allows loosening, and by removing a longitudinal section is tightened by bandage. It equally supports every square inch of surface and, if properly applied, makes no undue pressure at the flexions. It prevents interference by the mother or child, it retains the fixed position in spite of restlessness or motion while permitting frequent change of posi-

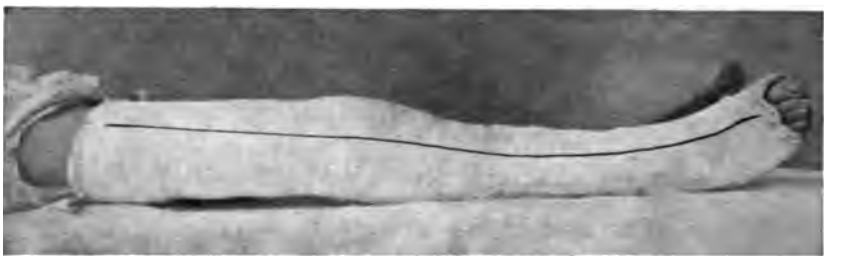


FIG. 283.—Fracture of tibia and fibula, with knee- and ankle-joints fixed with plaster cast, which is slit open so as to be readily loosened if necessary.

tion; it relieves pain and spasmodic twitching almost at once; it maintains the reposition secured by the surgeon without danger of displacement; it permits easy nursing without risk; it allows an infant to be put to the breast, or an older child placed in a rolling chair within a few days after the injury. In an adolescent it permits crutch locomotion; it guards against injury from the traumatisms of recklessness, and, if the fracture is in the upper extremity, it allows without risk the continuance of school or of occupational life.

Splints of wood, felt, leather, binder's board or metal are far less secure, since bandages will slip or loosen and can also be meddled with by parent or child. The author knows of a fracture box attached to a broken

leg having been dragged upstairs. Had this limb been securely fixed with gypsum the malpractice suit that followed would not have resulted.

Passive motions and gentle massage and hot air bakings should commence early to restore function; for the elbow in two weeks. As early as safety permits, portions of the cast should be cut off to permit movements of the fingers, wrist or ankle and avoid agglutination of muscles. In active boys, a short plaster cast applied to an arm for several weeks after union may prevent refracture through carelessness.

For TRANSPORTATION in cars or vehicles, a plaster-of-Paris cast offers the surest safeguard against displacement or injury.

FIG. 284.—Feeble delayed union of tibia and fibula.

DELAYED UNION.—If mobility remains after the usual time of solidification the splints should be reapplied for several weeks. Many angulations and deformities are the result of allowing a child to bear weight on a limb too early, especially if an attack of sickness should delay union or subsequently soften the callus.

NON-UNION; UNUNITED FRACTURE; PSEUDARTHROSIS.—Non-union or delayed union from retarded callus formation (Fig. 284) may result from various causes, as marked displacement of fragments, interposition of muscles or fascia, tendon or nerve injury, great contusion at the time of injury, inefficient treatment or general malnutrition. The employment of the X-ray has naturally aided effective replacement and fixation and lessened the cases of non-union.

Ununited fracture is less frequently encountered in children than in adults, yet even an intra-uterine fracture may fail to unite, or a bone broken during birth, if unrecognized, may remain ununited, but union is usually speedy if the fracture is dressed in plaster immediately after birth. Delayed and persistent non-union in adolescents should be treated by persevering application of fixation splints. Smith's thigh support and the author's convalescent hip splint (Fig. 429, p. 480) are useful in facilitating locomotion. Operation in adolescents may occasionally be required. Wieder states that there is usually sufficient callus formed on the internal side of an angularly deformed fracture to almost re-establish the original line of the bone from one point to the other and that vicious union after fracture may be safely rebroken, up to nine months or later.

The hypodermic injection of gelatin incurs the danger of tetanus. The persistent and long continued concussion made with the hand (tapotement) and the wearing of a supporting-enveloping walking-apparatus are sometimes successful in promoting union.

FIG. 285.—Non-union of tibia and fibula united by wire sutures and enclosed in cast.

Based upon the theory that the extravasated blood is the cause of the inflammatory action that results in callus formation, the injection between the fragments of 20 to 40 c.c. of venous blood drawn from the arm of the patient has been employed. The syringe must be strong and the blood injected between and around the fragments, guided by a skiagram of the area. The injection should be repeated four or five times at intervals of ten days, in cases that refuse open operation. Added to this is the employment of Bier's elastic PASSIVE HYPEREMIA. The injection of iodine or turpentine between the fragments is helpful. If open operation is required, the bones being exposed, they may be sutured as in the adult by wires (Fig. 285), or plates (Fig. 286), or ivory-tipped screws with removable heads. Magnuson[1] demonstrated very conclusively that ivory screws if cut off level with the periosteum do not act as foreign bodies but become incorporated with the bone or are absorbed. A special tap ensures easy entrance for the screw, and its thread holds it in place much better than a peg, thus preventing separation of the two portions of bone by interposing callus.

In Agnew's Surgery, vol. i, 841, 2d edition, will be found an excel-

[1] Magnuson, Univ. of Penna. Med. Bull., May, 1908.

lent summary of the older methods of treatment, fixation, friction, scraping, drilling, electro-puncture, nailing, setons and resections.[1]

Deformity after Fracture; Vicious Union.—Deformity in children, especially near a joint, and partial ankylosis should not lead the surgeon to too speedy operation, since time, involuntary and voluntary movements, massage and the natural activities of the child will often pro-

Fig. 286.—Ununited fracture of fibula held in place with silver plate and screws.

duce wonderful results. A bent-bone or greenstick fracture should, however, be reduced under ether, as soon as it is discovered. In angular union, refracture or osteotomy may be necessary.

Angulation, overlapping and other deformities of the leg may follow fracture. If discovered early such deformities are best treated by bending over a narrow wooden block (Fig. 619) or by refracture. If firmly united, especially if faulty rotation has taken place, osteotomy with bone knife is advisable (p. 296) with restoration and retention by fixed plaster dressing, or an open operation, with wiring, or supplementary fixation with screws, or plates will become necessary.

[1] For methods of Greeks and Romans, see Interstate Med. Jour., St. Louis, Jan., 1909.

Open Treatment.—The direct fixation of fragments by open incision and suture [1] secures more certain approximation and retention of fragments and the method should be employed when clinical evidences and the X-ray show that etherization and replacement have failed to reduce and retain the fragments. In children the open method should be reserved for exceptional cases. If primary union of the wound is secured, the time of recovery is shortened, yet the possibilities of infection should always be taken into consideration, since even with the most careful asepsis, errors of preparation or of technic may occur. The healing may be prolonged and the amount of callus greater than by splint treatment. The disturbance of periosteum often results in necrosis of portions of bone, and wires frequently require removal. Chromicized gut or kangaroo tendon is better than wire and is sufficiently stable. The report of Ashhurst is worthy of thoughtful consideration (p. 359, under Femur).

CLAVICLE.

Fractures of the clavicle in very young infants may be produced by falling out of bed or by violent jerks of the arm by an older child or nurse. The child will scream and cry when moved but may still toss the arm. Crying will increase on local manipulation. Mobility, swelling and deformity

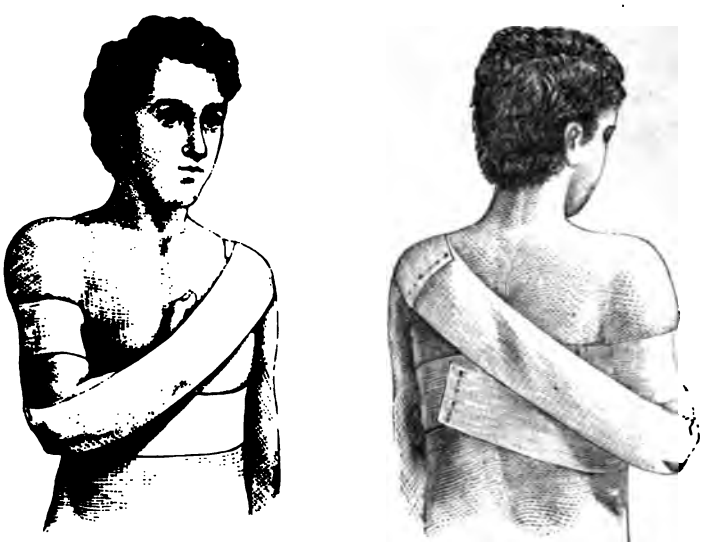


FIG. 287. Sayre's dressing for fracture of the clavicle. (Wharton and Curtis.)

are present, but not crepitus, as the injury may have caused only a bending or angulation. In children under ten this injury is very common.

Treatment.– The skin is dusted with stearate of zinc, a small bit of absorbent cotton placed in the axilla, a tubular stockinet undershirt applied and the arm and forearm firmly secured to the chest with a Velpeau band-

[1] Arbuthnot Lane, Practitioner, Feb., 1909; Trans. Surg. Section Amer. Med. Assoc., 1909; Jour. Amer. Med. Assoc., 1909.

age, or anchored by a tight muslin underwaist. The dressing should be removed as seldom as possible, cleanliness being facilitated by inserting next the skin a loose perpendicular strip of bandage. Wrinklings of the bandage and loosening may be prevented by sewing the turns to the waist or by an outside layer of starch or silicate of soda or by adhesive strips. Union will occur in two weeks, but the arm should be restrained for an additional week.

The deforming action of the sternomastoid may be lessened by inclining and fastening the head toward the injured side.

In older cases the shoulder may be drawn backward by broad strips of zinc oxide adhesive plaster, carried from the point of the shoulder diagonally across the scapula and around the opposite side to the front of the chest. With cotton pad in the axilla the humerus is lifted by a broad sling of the same plaster; another wide strip fastens the forearm flexed at the elbow and both arm and forearm to the chest (Bellamy).

Sayre's dressing consists in applying a wide strip of adhesive plaster around the upper arm, then across the back and around the chest. The second strip is applied diagonally from the elbow of the injured side to the sound shoulder, passing both in front and behind the thorax, and fixing the hand in front of the opposite shoulder (Fig. 287).

HUMERUS.

Fracture of the upper end of the humerus in children (Fig. 288) is less probable than SEPARATION OF THE UPPER EPIPHYSIS, or a DISLOCATION. In epiphyseal disjunction or fracture there is usually a sharp projection of the lower fragment inward that rotates with the shaft while the upper fragment is stationary below the acromion (Fig. 289). In dislocation the rounded head moving with the shaft will be found in the axilla while the space under the acromion is vacant. Crepitus is more probable with fracture but preternatural mobility will be present in both epiphyseal separation and in fracture, while in dislocation rigidity will be noted. A surgeon unfamiliar with X-ray anatomy may wrongly interpret a normal epiphyseal line for a fracture (p. 6).

FIG. 288.—Fracture of surgical neck of the humerus.

Treatment.—Anesthesia is necessary for diagnosis and for reduction. An X-ray will usually confirm the clinical diagnosis and exhibit the amount of displacement. Whitman[1] advises the reduction of the fragments under ether and the slow forcible carrying of the arm into extreme abduction, using the acromion as a fulcrum, combined with hand elevation in the

[1] Whitman, Annals of Surgery, May, 1908, 706 and xxxvi, 787.

axilla. A plaster-of-Paris shoulder spica is then applied in abduction which elevation is retained for three weeks, after which massage and gymnastic exercises are to be applied persistently.

Fracture or epiphyseal separation may take place during birth, if too great traction or rotation is made upon the humerus by the accoucheur. Pain, disability, swelling, deformity and sometimes crepitus will mark the accident and the X-ray may assist in a correct diagnosis from dislocation. If reduction is thoroughly accomplished under ether, a pad of boric cotton in the axilla and a simple Velpeau bandage for two weeks will secure a good result.[1] If autoinfection from the umbilicus takes place, an osteomyelitis or suppurative arthritis may follow.

FIG. 289.—Fracture of humerus with impaction and overriding of fragments.

Lifting a child by the arm, or suddenly jerking the humerus upward and outward is very liable to cause a separation of the epiphysis. The pectoral and latissimus dorsi being inserted into the diaphysis, strongly resist such applied force. The head is held firmly by the subscapularis, the infra- and supraspinatus and teres minor, and the unossified epiphysis consequently yields. The lower fragment is usually conical and fits into a depression in the head (Fig. 289), but may be drawn inward if separation occurs.

FRACTURE OF ANATOMICAL NECK WITH DISLOCATION OF HEAD is a rare condition in children and would practically always be an epiphyseal separation. The author recalls but a single case in an infant. The head of the bone had been cut down upon by a surgeon, but the reduction had been abandoned. When first seen, months later, the child had secured such good shoulder motion, although the head was still in the axilla, that operation was not advised. If efforts at reduction fail, the head may be reached by anterior incision,[2] carefully guarding vessels and nerves, and the head of the bone removed or fixed with ivory screws.

In fracture BELOW THE INSERTION OF THE DELTOID if the upper fragment is tilted outward and cannot be reduced, the lower fragment may be abducted far out from the body and fixed in that position with plaster cast.

[1] Packard, Keating's Enc. Dis. of Chil., iii, 1062.
[2] Buchanan, Annals of Surgery, xlvii, 659, 672, and li, 267.

Boys are liable to fracture of the shaft by muscular action in arm twisting sports. Fractures of the shaft are particularly liable to be followed by non-union, owing to injury of the musculospiral nerve or of the nutrient artery, at the time of the original accident.

Treatment.—Fracture of the shaft in children can be best restrained and protected by applying a plaster dressing from axilla to wrist. If unruly, the shoulder and thorax should be included. With elbow fixed at right angles, the cast may be slit when partially hardened either along its concave or convex border or both. A wooden anterior or an internal angu-

FIG. 290.—Fracture of lower condyles of humerus.

lar splint with three short splints of felt or binder's board or metal or wood is often employed with sling. The elbow should not be lifted by the dressing.

In older children the pad in the axilla should be only a layer of absorbent cotton well powdered. After complete reduction of the fragments the shoulder should be covered with a binder's board cap and the arm firmly fixed against the side of the chest with adhesive strips or bandage or gypsum, the forearm being placed in a sling without support of elbow.

Gentle passive movements are commenced in three weeks and manipulations, massage, and gymnastic movements continued until thorough motion is secured at the joints.

Elbow.—The supracondyloid and the T- or intercondyloid fracture of the humerus is common in children. A fall upon the elbow drives the olecranon forward as a wedge, splitting the condyles (Fig. 290). A fall upon

the hand drives the coronoid backward with the same result. In infants, the capitellum, the trochlea and the two epicondyles enter into the epiphysis. Normal consolidation with the diaphysis does not take place until the fourteenth to the seventeenth year and in the olecranon about the eighteenth. Fracture of the epicondyle may occur without the break extending into the joint. The three points, the olecranon and the two condyles, should be in line and equidistant when the joint is in either flexed or extended position.

Fractures at the lower end of the humerus extending into the joint are frequent and are exceedingly productive of subsequent disability and loss of motion. In children under fifteen years of age, separation of the epiphysis is not uncommon. Crepitus may or may not be present but mobility and deformity will exist. Many so-called sprains are partially epiphyseal disjunctions and partially fractures.

FIG. 291.—Fracture of condyles of humerus with backward dislocation of lower fragment.

In T-fractures extending both transversely and obliquely or longitudinally into the joint, the inner trochlea or epitrochlea may be split off or the outer condyle or the epicondyle may be broken, the latter sometimes independently by a direct blow. Fracture of the inner condyle is the more serious, since if its position in the joint is altered, deformity will result. The normal extension of the forearm in supination is at an angle of fifteen degrees with a line extended from the longitudinal axis of the humerus. The hand in supination should hang far out from the outer side of the thigh—the "carrying position"—in standing.

In a transverse fracture of the lower end of the humerus the action of the triceps and biceps muscles tends to draw upward and backward the lower fragment and produce forward angulation at the seat of fracture, with prominence of the olecranon simulating backward dislocation of the elbow (Fig. 291); but the olecranon will be found on examination to bear its normal relation to the two condyles. Mobility and crepitus are usually appreciable, provided the swelling is not too great. An anesthetic and an X-ray are usually necessary to determine the extent of the injury. If a T-fracture exists the condyles can be moved upon each other (Fig. 292).

Treatment.—Reduction is best accomplished under ether by strong HYPEREXTENSION followed by TRACTION and FORWARD PRESSURE on the lower fragment until COMPLETE flexion can be secured.[1]

An emergency splint for fracture near the elbow is readily made from binder's board or stiff card-board or leather, by cutting a V-shaped notch on either side, bending the splint at right angles and pinning the three pieces together with rivets such as are used in holding sheets of paper, or

[1] Lusk, Ann. of Surg., Sept., 1908, and xlviii, 432.

with eyelets. Wood, felt, galvanized iron, leather or any stiff materials may be used for splints but are not as convenient or as effective as gypsum.

In a diagonal fracture of the internal trochlear surface extending into the elbow-joint and in a T-fracture, many surgeons fail to recognize the normal angle of the forearm to the line of the arm during supination but dress the fracture in the straight line, thus sliding up the inner fragment and compelling the "gunstock" deformity (Fig. 293.) Many methods have

FIG. 292.—Fracture of condyle of humerus with forward displacement of forearm.

been devised to correct this result. The author has had best results by following the plan of Allis and of Wyeth.[1] The forearm is extended, supinated and ANGULATED NATURALLY TO THE RADIAL SIDE TO CORRESPOND TO THE ANGLE OF THE OPPOSITE ARM. The forearm should never be dressed in a STRAIGHT line with the ulnar aspect of the upper arm, as this would be an unnatural position. A forearm in straight line with the arm is only seen in patients with relaxed long ligaments. To prevent this gunstock deformity Allis applies to the arm and forearm several thicknesses of long longitudinal strips of adhesive plaster, securing the normal angle and permitting early limited motion. When carefully adjusted under ether and fixed in extension with plaster of Paris from axilla to carpus at the normal angle, no change can take place and the child is comfortable and protected from injury. In rebellious children a plaster cast should be applied to include the SHOULDER and CHEST. At the end of the tenth day gentle passive motions are commenced and the splint shortened at the wrist in order to allow finger movements. In the third week, a fresh cast with change of angle is applied, with daily removal of the splint and massage and voluntary movements encouraged. Early passive movements repeated under nitrous oxide anesthesia, in addition to the natural movements of

FIG. 293.—Gunstock deformity after fracture of internal condyle. Result of arm having been dressed without regard to normal angle of the bones at the elbow. (Allis.)

[1] Wyeth's Surgery, 2nd edition, p. 161.

the child, will almost invariably give an excellent joint. With a restless boy a removable gypsum or silicate or starch or protective splint should be continued for several weeks to avoid refracture.

In transverse fractures above the joint the flexed position (Fig. 294) is excellent but is dangerous in the production of gangrene from pressure on the brachial vessels or nerves if tightly applied.

Jones[1] advises immediate supination and acute flexion of the forearm and its retention in that position in a sling for four weeks. He recommends this position in all fractures of the elbow of both external and internal condyles—except those of the olecranon. This method avoids the use of splints and bandages but interferes with circulation. If stiffening occurs, voluntary motions by the child will in a few months give a useful arm. Voluntary motions are safer than passive ones, but after union is firm, progressive massage and gymnastic movements will establish good function.

FIG. 294.—Plaster-of-Paris splint holding forearm in extreme flexion. (Lusk.)

Fracture of the outer condyle is not as serious as a break of the trochlea. A fracture of the epicondyle does not enter the joint and requires only support of adhesive plaster and a sling.

COMPOUND fracture of the elbow is treated with thorough antiseptic cleansing, the adjustment of fragments, wiring them in proper position if necessary for retention, fixing the elbow at a right angle in a plaster cast divided in half (see p. 244) to be readily removed for dressings. The primary aseptic dressing should not be removed until odor arises. More risk can be taken in children than in adults in retaining fragments, but excision of fragments, rather than of the joint, should be the rule, as a useful arm can often be secured if voluntary and involuntary movements are commenced after twelve or fourteen days.

AMPUTATION should be done only in absolutely hopeless cases, as remarkable results are possible with wise aseptic conservatism.

ELBOW ANKYLOSIS.—While stiffening of the elbow is common, yet complete ankylosis is rare in children if movements are commenced early. So important is motion at this joint that it is wiser, especially in boys, to take the risk of slight deformity.

Ankylosis after fracture in children is best prevented by early volun-

[1] Jones, Clin. Journal, Oct. 26, 1904.

tary motions to the limit of not producing serious pain, to which may later be added passive movements by the surgeon under nitrous oxide anesthesia. Splints may be removed as early as the end of the second week if the child is tractable. If ankylosis has occurred, the joint may yet be restored by persistent efforts. Excision and arthroplasty are undesirable, as epiphyseal growth may be injured by too early intervention. Excision even later is apt to leave a weak flail arm.

ARTHROPLASTY offers better results in adolescents. The olecranon should be sawed through, the two joint surfaces gouged and fashioned as accurately as possible to the normal, and a large fascial and fatty flap cut from the back of the arm[1] and inserted to cover the whole area of the new joint. This should be stitched in position with chromicized gut and motion cautiously commenced at the end of the second week.

RADIUS AND ULNA.

A fractured OLECRANON is drawn upward by the triceps (Fig. 295) and if complete replacement is impossible, an open operation becomes necessary. With the hand in the position of supination, the olecranon can be exposed with less risk of injury of the ulnar nerve than when in pronation. If the fragments can be brought together with the forearm in extension, by chromicized gut passed through the periosteum and fascia, the bone need not be drilled. If drilling is done, a single or a mattress suture of strong chromicized gut or wire, or ivory screw with removable head, with the arm dressed in extension in a plaster cast, will give an excellent result. In posterior dislocation with fracture of the coronoid, a recurrence of the dislocation may take place after reduction unless great caution is used. Epiphyseal separation of the olecranon is rare.

FIG. 295.—Fracture of olecranon and condyles of humerus.

The epiphysis of the head of the radius unites with the diaphysis at about sixteen years of age, the lower at eighteen. A violent jerk on the arm of a young child may be followed by epiphyseal separation. As the epiphysis lies within the articular ligament, the cavity of the connected elbow-joint is liable to effusion.

On pronation and supination the epiphysis will not rotate under the finger and the X-ray will probably show a separation. In subluxation,

[1] Murphy, Trans. Amer. Surg. Asso., 1906; Jour. Amer. Med. Assoc., May, 1905.

rotation is present. Subluxation of the head of the radius[1] or of the articular ligament or "pulled elbow" or elbow sprain, is frequent in young children, due to rough treatment of the hand and forearm. The head of the radius may partially or entirely slip from the orbicular ligament, or there may be a partial separation of the epiphysis. The X-ray is of slight value in diagnosis. Replacement may be sometimes effected by strong supination.[2] The head can be readily distinguished just below the outer condyle of the humerus and if the radius is unbroken or impacted it should be felt to rotate during pronation and supination.

In FRACTURE OF THE SHAFT of one or both bones of the forearm, accurate reposition and adaptation should be followed by immediate enclosure in a removable plaster cast, from axilla to carpus, as described (p. 244). If gypsum is not at hand, a posterior straight splint, or two straight splints well padded may be used. The advantage of dressing the hand in supination is shown in Fig. 165, p. 246.

If wooden splints are employed the danger of ischemic paralysis must never be overlooked.

ISCHEMIC PARALYSIS (Volkman's) is more common after fracture of radius and ulna than in any other region of the body and occurs from the tight application of two wooden splints. A slough upon anterior or posterior aspect of the forearm and subsequent contractions bind muscles and nerves in a dense cicatrix poorly supplied with blood-vessels—a traumatic myositis. This is a most unfortunate accident both for patient and surgeon. (For treatment see p. 650.)

INCOMPLETE or GREENSTICK fractures are common in the forearm in children. Deformity is present, but mobility and crepitus are absent.

In greenstick fracture, the bone or bones should be forcibly but slowly straightened by the surgeon's hands over a narrow wooden fulcrum (Fig. 619, p. 680), under anesthesia, even if complete fracture results. The forearm and carpus are then encased in gypsum, allowing finger motion, and the hand placed in a sling. The hand can be released in a week or ten days. If rebending occurs, or if the deformity is not discovered until late, the forcible straightening should be accomplished as soon as detected; still later, OSTEOTOMY or OSTEOCLASIS may be necessary.

Fracture near the LOWER END of the radius, either Colles' or Barton's, is sometimes productive of great deformity and loss of function. If not seen immediately, the swelling may mask the injury so that the characteristic SILVER-FORK displacement is concealed. Even when no crepitus is present, the bony deformity, the immediate loss of function and the pain are sufficient to demand the taking of two X-ray shadowgrams, and the administration of ether for diagnosis and treatment.[3]

The violence of the fall may drive the upper into the lower fragment and firmly lock it there, so that crepitus and mobility will be absent and deformity will be marked. The X-ray will assist in disclosing the lesion.

As the hand is nearly always in pronation during a fall, the deformity is characteristically distinct, even if it is but slight. The hand will be

[1] Piersol's Anatomy, 1908, 293.
[2] Thomas, Ann. Surg., Aug., 1907; Amer. Jour. Orth. Surg., Apr. 18, 1908.
[3] Willard, Phila. Polyclinic, ii, 188.

carried with the lower fragment backward and to the radial side, the projection of the anterior articular lip of the radius in front of the wrist will be absent and the carpus will project backward. Rarely anterior displacement of the lower fragment occurs provided the carpus has been forcibly thrown forward in palmar flexion. Colles' fracture of the radius is often accompanied by a fracture of the styloid process of the ulna.

Treatment of Colles' Fracture.—In fracture of the lower end of the radius either above or into the joint (Colles' or Barton's) with characteristic silver-fork deformity, *immediate* and *complete reduction* under anesthesia, by traction and forcible manipulative flexion and extension with unlocking of the fragments, is the only proper treatment. Molding the parts to the original position will greatly facilitate not only good union but will avoid subsequent stiffness and deformity. If reduction is fully accomplished there will be but little difficulty in *retention*, light splints

Fig. 296.—Levis' splint for fractured radius with hand in palmar flexion. (Agnew.)

only being required as protectors. Some surgeons even trust simply to bands of adhesive plaster, but this method is unsafe in children. When forcible reduction fails, an open operation should be done, the osteotome or chisel being used to loosen and adjust fragments. Roberts[1] has shown that difficulty in reduction of the deformity of the radius is sometimes due to a coexisting unrecognized greenstick fracture of the ulna.

In docile children such a fracture at the lower end of the radius and ulna after complete reduction under ether, can be safely dressed in the supine position in plaster-of-Paris extending from elbow to the metacarpal bones, to permit movement of thumb and fingers. In troublesome cases it is wise to fix the elbow. The cast should always be slit before it has thoroughly hardened, to allow for swelling and to permit inspection (p. 244). A straight wooden dorsal splint, or two wooden splints, or a metal support may be employed (Fig. 296).

In all fractures of radius and ulna, the voluntary use of the fingers should be permitted from the beginning, to prevent inflammatory adhesions.

[1] Roberts, Ann. Surg., Aug., 1909.

If previous reduction of fragments has been thorough, gentle wrist movements can also be instituted at the end of the second week. When contusion has been great, long continued massage, hot air baking, and muscular exercises in a properly equipped gymnasium will greatly assist in securing good movement.

Cases seen late, with deformity, loss of pronation and of function, should be opened. Avoiding vessels and nerves, the fragments should be separated with osteotome and complete reduction effected, even by the application of force if necessary. Reposition and retention are sometimes difficult but may be assisted by hyperflexion and hyperextension of the hand. Great force temporarily applied is safer than after-pressure by pads and splints which are dangerous as regards sloughing and infection.

For REFRACTURING a forearm that has been badly united, the strong hands of the surgeon and a narrow wooden block are essential. Resistant cases may require the use of a wrench (Fig. 162, *A*, p. 243) or an osteoclast (Fig. 249, p. 300), but osteotomy is more accurate.

Epiphyseal Separation.—The lower epiphyses ossify about the tenth year and are united to the shaft before the twentieth year. Separation of the epiphysis, especially that of the radius, is exceedingly common in children, just as fracture at this point is common in older subjects because hands are always thrown forward for protection in falls and accidents. Differentiation from fracture is difficult as even a radiogram may misinterpret (Fig. 5, p. 6). The deformity is occasioned by the backward displacement of the carpus and lower fragment and their retention by the supinator longus, while the pronator quadratus and the anterior tendons are put upon the stretch and fix the injured region.

TREATMENT OF EPIPHYSEAL DISJUNCTION.—Under ether the epiphyseal lower fragment must be first forcibly extended and drawn downward to unlock the interdigitations; then flexed and carried to the ulnar side until all deformity has disappeared. When reduction has been thoroughly accomplished there will be but little tendency to recurrence and a light splint will be sufficient. A gypsum cast, however, is safest for retention and protection.

EPIPHYSEAL INJURY or fracture of ONE bone at the lower forearm may so interfere with subsequent growth that the hand will be pushed to the radial or to the ulnar side by the normal bone.

Such a condition may be remedied by resection of a portion of the longer bone, or by elongating the shorter one by the method of Magnuson[1] by mortise section, traction and the insertion of ivory screws specially designed with brass removable heads (p. 335).

HAND.

In children carpal fractures, though rare, except of the compound variety, are often treated for bruise or sprain. An X-ray of both hands is desirable, as the swelling and pain often render diagnosis difficult. Both anteroposterior and lateral views are advisable. Pain, swelling and disability will be the chief symptoms, crepitus will be rare. The point of

[1] Univ. Med. Bull., May, 1908.

greatest tenderness will usually be posterior. A fall on the extended hand is frequently mistaken for sprain, but ether will make diagnosis clear.

FIG. 297—Short screw inserted in non-union of phalanx.

Treatment.—Immobilization by plaster in straight position of wrist, but with the fingers free to allow movement, is the safest dressing. In fifteen days the splint is removed unless the child is too active, adhesive

plaster strips applied and gentle movements permitted. Later, massage and free movements are necessary.

If reduction of fragments is impossible under ether, one or both fragments of carpal bones are removed through a posterior incision.

Rarely non-union occurs. After several months of delay in a case of defective nutrition, the author secured firm union of a phalanx by the use of a screw (Fig. 297).

The treatment of fracture of the metacarpals and fingers in children does not differ from that of adults, except that motion is permissible earlier. A phalanx may be broken and yet show neither displacement nor crepitus (Fig. 298).

Fig. 298.— Fracture of phalanx without recognizable displacement.

For tiny infant fingers, card-board strips or toothpicks and adhesive plaster answer well. For boys, who often break the metacarpals or fingers by hard blows, plaster-of-Paris is the best material for splinting, but after thorough reduction of the fracture, a tight adhesive plaster strapping will often enable the patient to continue at school or at work.

PELVIS.

The pelvis is rarely fractured in children except by crushing forces that require the same treatment as in adults.[1] The author recalls a patient in whom only the anterior superior spine was broken off by a fall from a horse, upon a stone just large enough to pass in between the trochanter and crest of the ilium. The pelvis is sometimes broken by falls upon the buttocks from a height.

An adolescent patient of the author's in falling from a bicycle struck directly upon the trochanter, breaking the neck of the femur and at the same time crushing the floor of the acetabulum. The spicules wounded the peritoneum but recovery followed with slight shortening and stiffness (Fig. 299). In another case seen in consultation with Dr. Spellissy, a patient in the delirium of typhoid fever leaped from a second story window and drove the entire femoral head inside the pelvis.

Absolute rest in bed, complete relaxation of muscles, and fixation of trunk, pelvis and thighs in an enveloping plaster cast are essential for the support of a fractured pelvis.

FEMUR.

Fracture of the femur or epiphyseal separation is sometimes produced in a new-born infant by too strong traction by finger or blunt hook in a head-last labor, or in rotary attempts to bring down the legs. Pain, swelling and preternatural mobility will be present but crepitus rarely.

The diagnosis between fracture of the femoral neck and epiphyseal disjunction is difficult and the X-ray is not of much service at this cartilag-

[1] Willard, Trans. Phila. Path. Soc., xi, 18.

inous age. In autoinfection from the umbilicus, the accident is sometimes followed by suppuration, from acute infectious epiphysitis or osteomyelitis.

Treatment of Infants.—As soon as a fracture of shaft or of neck is discovered, tubular stockinet should be applied from chest to ankle, and a longitudinal muslin bandage laid loosely next the skin (p. 731), the latter being

FIG. 299.—Final result of fracture of neck of femur and floor of acetabulum.

thoroughly powdered with zinc stearate. A thin layer of absorbent cotton is applied with flannel bandage, and under full anesthesia the surgeon adjusts the fragments and maintains TRACTION while an assistant applies a spica plaster-of-Paris bandage rapidly about the fracture, with thigh at right angle to the body, afterward completing the cast from the ankle to thorax. The sides and groin are strengthened by reverses. When hardened, this

cast is cut back well away from the genitals, shellaced and the anus packed about with absorbent cotton and rubber tissue beneath the diaper. With care, this cast need not be seriously soiled for weeks and the infant can be moved as required and placed at the breast.

Symptoms of Fracture at the Neck of the Femur.—Immediate disability, slight shortening, eversion of limb, and relaxation of fascia lata are sufficient diagnostic proofs of the lesion in older children. An attempt to secure crepitus is productive of increased deformity.

In fracture of the neck in childhood, the line of break is usually both intra- and extra-capsular. The trochanter will be above Nélaton's line (Fig. 300) and the base of Bryant's triangle will be shortened. The distance from the outer side of the trochanter to the median line will be diminished.

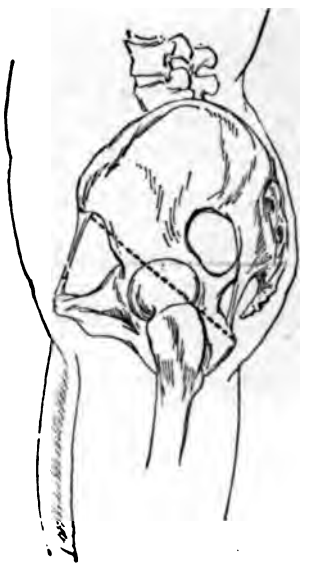


FIG. 300.—Showing Nélaton's line passing from the anterior spine to the tuberosity of the ischium. (Piersol's Anatomy.)

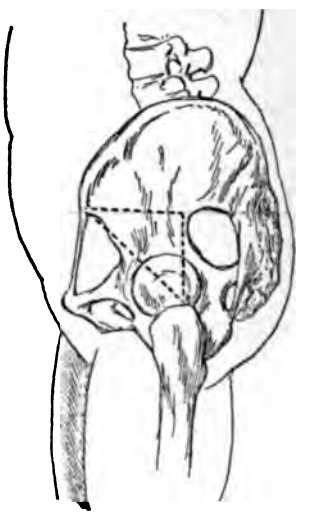


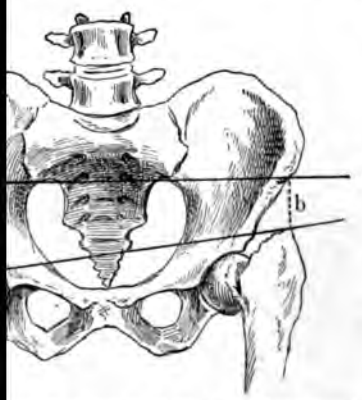
FIG. 301. — Showing Bryant's triangle. The outer and upper base line are unequal in fracture of the femoral neck. (Piersol's Anatomy.)

In fracture of the neck of the femur, in dislocation either congenital or traumatic, and in hip disease with pathologic dislocation, an excellent diagnostic help is to draw a line with skin pencil from the top of the trochanters across the anterior superior spines to the median line of the body. In normal conditions these lines should meet at the centre. With a horizontal line connecting the trochanters and the projection of the median line, two right-angled triangles should be formed with bases looking downward.

Another test (Bryant) is to draw lines from the anterior superior spines to the trochanters (Fig. 301). A line perpendicular to the trochanter should meet at right angle with a line drawn backward from the anterior spine.

Another test is to connect the two anterior superior spines and the tops of the two trochanters (Chiene, McCurdy). If the neck is shortened, these two lines will not be parallel (Fig. 302).

test is to compare, with tape line, the respective distances tre of a line joining the two anterior superior spines, to the to the tips of the condyles of the femurs. Robson's and Morris' lines also assist in diagnosis.



owing elevation of tip of trochanter and of Bryant's triangle in fracture of neck on sound side; *b*, on fractured side. The n line of the body will also be altered. r.)

Treatment. — In epiphyseal separation or unrecognized fracture of the neck, union may take place at an angle with a bend that may be mistaken for coxa vara in adolescents (see Coxa Vara, p. 310).

In adolescents, the gypsum dressing is advisable, but when muscles are strong and good apposition cannot be secured, Buck's extension over pulley wheel in the vertical position may be employed. If horizontal extension (Fig. 420, p. 474) is long sand-bags are essential; ordinarily they are entirely too short enveloping splints of binder's board or leather or felt are on's and scores of have been devised of the femur, but geon is accustomed use of gypsum he le need for other

et of success in the er-of-Paris lies in it is applied to the ion while the sure fragments accution. These once he upper and lower ss importance can he plaster loosely 246). The bones being thoroughly ealing process will thout deformity. llus is fairly firm, of sufficient age, Thomas posterior bar fixation hip splint applied (Fig. and be allowed to go about with crutches and high shoe oot.

FIG. 303. — Suspension gallows for vertical extension in double fracture of the femur. (Bernstein.)

Jones applies a Thomas knee splint, with metal thigh-encircling ring pressing against the ischium and ramus of the pubes, making a fixed point for extension by straps from the foot-piece. The side bars, with two curved lateral splints of sheet iron or binder's board at the seat of fracture, give excellent immobilizing support.

In fracture of BOTH FEMURS in a young child the plaster dressing is applicable; or vertical extension may be employed by zinc oxide adhesive plaster strips, with cords over a couple of pulley wheels in the ceiling or in a gallows over the crib (Fig. 303). The weights should be just sufficient to slightly lift the buttocks from the bed. This position, however, permits

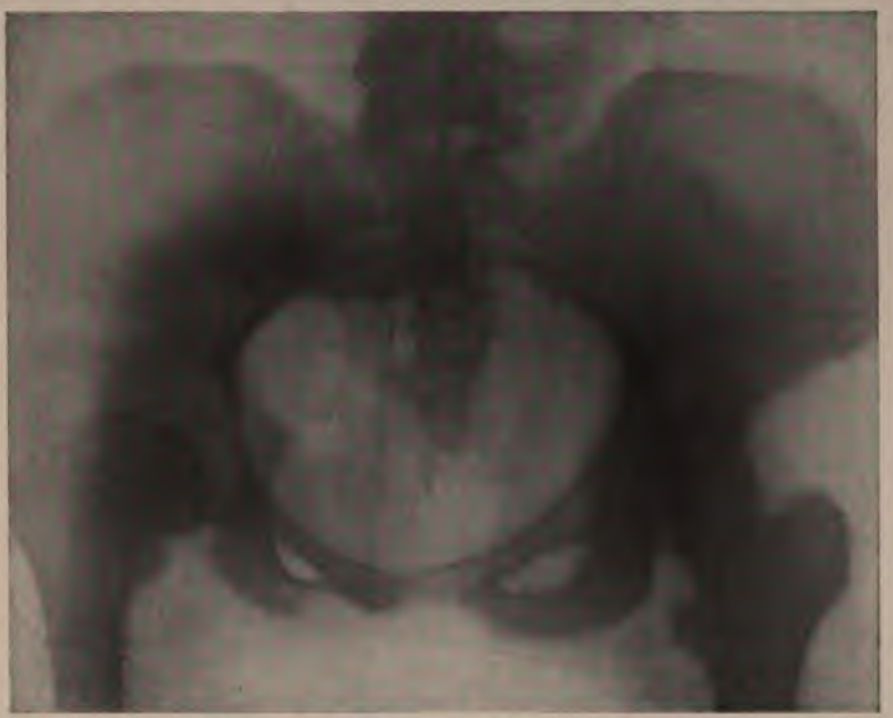


FIG. 304.—Fracture of femoral neck with absorption and shortening.

much greater movement of the fractures than does a gypsum cast and a nursing child cannot as readily take the breast as when on a bamboo frame. A gallows for vertical extension can be erected on a gas-pipe bed frame (Fig. 362, p. 422) permitting removal from bed to trestles.

The femur may be broken by twisting or rotation in attempting to forcibly move an ankylosed hip (Fig. 304), or in the reduction of a congenital dislocation of the hip, or in hip resection when the bone is atrophied.

Between five and fifteen years of age if horizontal pulley extension instead of the gypsum cast is employed, movements of the fragments will be prevented and ease in handling secured by placing the patient on a bed frame (p. 422).[1] This will allow the patient to be carried out of doors and

[1] Silver, Ann. of Surg., Jan., 1909.

or cleansing and for bowel movements, by placing the ends of on blocks or hassocks. In fracture of the femur treated by e raising of the hips upon a bedpan is very disturbing to the It is much better with either boy or girl to use a small pus-pan and feces. A very slight rolling upon the side will permit the ced beneath the anus.

through hip-joint, showing epiphyses of head and greater trochanter of femur. (Piersol's Anatomy.)

ren, fracture of the neck or epiphyseal separation sometimes direct lateral blow and the head of the bone may be driven floor of the acetabulum (p. 350). Epiphyseal separation is n in children than fracture of the neck,[1] since the head is not haft until the age of nineteen or twenty (Fig. 305).

ON of the fragments and IMMOBILIZATION WITH PLASTER-OF-UCTION. Whitman has rendered a great service in fracture of eck, not only in children but also in adults, by showing the ben- ived in approximation of fragments by the strongly abducted securing a useful union (Fig. 306). As the proximal frag-

[1] Whitman, Amer. Jour. Orth. Surg., Aug., 1909, 143.

ment cannot be reached, it is important to bring the distal fragment into proper alignment with the central one. After an X-ray examination and under full anesthesia, the limb should be carried slowly and gently outward until it presents an angle of 45 degrees with the body, the pelvis being fixed by carrying the sound leg to the same angle on the opposite side. Three assistants are necessary, one for each leg, another to make counter-traction on the shoulders while traction extension is made in the abducted position. The surgeon meantime corrects outward rotation and molds and lifts the lower fragment into position. The patient should lie upon a pelvic stool (Fig. 448, p. 494) while the shoulders are supported by a firm box, so that no movement of the body occurs during the application of the plaster.[1] Cotton wadding held in position by a smooth flannel bandage will protect

FIG. 306.—Leg fixed in abduction by gypsum cast for fracture of femoral neck. (Whitman.)

all bony projections. With the limb maintained in abduction to 45 degrees the bandage should be rapidly applied, first about the hip and pelvis, the region about the trochanter being molded to hold that area accurately in position while extension is made. The bandage should then be applied by the assistant to the body and thorax while the surgeon fixes the thigh, leg and foot in accurate position, molding the plaster about the condyles, patella and foot to prevent outward rotation.[2] The foot being finished last, permits traction to be continued until the end of the dressing without indenting the cast. This dressing should be applied as soon as the diagnosis is made, and should be worn for four weeks, after which time the part below the knee may be cut away. In six weeks the patient can walk on crutches, and in eight weeks a short removable spica of the hip or convalescent hip splint (Fig. 429, p. 480) or Thomas hip splint will suffice for protection, but

[1] Willard, Therap. Gaz., May 15, 1906, 299.

[2] Whitman, Ann. Surg., Feb., 1900, Nov., 1902 and Oct., 1909; and N.Y. Med. Record, Mar. 19, 1904; Therap. Gaz., May, 1906; Whitman's Orth. Surg., 3d ed., 1907, 565.

ld be used for three or four months, while massage and gentle assive gymnastic movements of the joint are given. By this cellent union without practical shortening can be secured, with unction (Fig. 307). This abducted position brings the frag- tter position than the longitudinal and lateral traction prac- nany. The treatment is also applicable to adults. Ridlon[1] child a modification of the Thomas posterior bar hip splint 76) with thoracic and pelvic bands, perineal straps and buckle the ankle. This dressing makes, when firmly bandaged to ry fixed and com- ratus. The child easily lifted for lacing in the open hildren can move ches.

fracture of femoral neck; luction and fixation for six n to normal straight line.

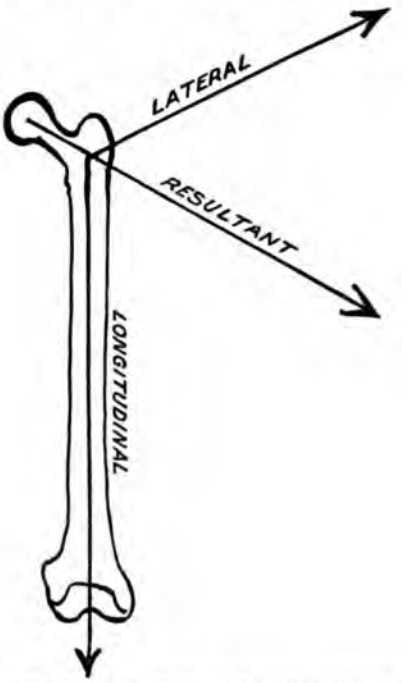


FIG. 308. — Ruth's longitudinal and lateral traction for fracture of femoral neck.

fracture of the femur, a long subsequent course of massage, ments and gymnastic exercises are important.

escents and for all ages, Ruth[2] advocates REDUCTION of the LEXING the thigh to right angles with the pelvis to relax the cus, simultaneously with OUTWARD TRACTION in the line of the until shortening and deformity are overcome. Permanent aintained by weight and pulley, supplemented by a lateral upper end of the lower fragment (Fig. 308). The foot and d are both raised to assist gravity. By this plan he claims on with certainty, even up to old age, and with serviceable is reduced, the bedpan can be used and cleanliness ensured.

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n, Annals of Surgery, July, 1901.
Gazette, Mar. 15, 1907; Jour. Amer. Med. Assoc., Aug. 26, 1899.

The side pull on the thigh may be distributed by applying a molded pasteboard splint.[1]

OLD INJURIES IN ADOLESCENTS will occasionally require operation. Several shadowgrams should be employed to determine the position and character of the fracture, the position of the fragments, the mobility of the caput, the amount of absorption (Fig. 309) and the total distance from the trochanter through the neck and head, so as not to interfere with the acetabulum.

FIG. 309.—Fracture of neck of femur with absorption.

With these data and with the radiogram before him the surgeon can make an incision, for complete exposure of the joint, from below the anterior superior spine to the top of the trochanter, then down along the femur. Muscular fibres must be incised as little as possible. The tensor vaginæ femoris and rectus are drawn inward, the gluteus medius and minimus upward and outward and the capsule incised without injuring the Y-liga-

[1] Moore, Northwestern Lancet, Mar., 1904.

U-incision with division and lifting of the trochanter gives also ntrance to the joint. The surfaces are then freshened and s fixed with ivory or bone screws or pegs, nails,[2] steel or wire, or staples.[3] The ivory screws with detachable heads Magnuson[4] (p. 335) are best, as they become a part of the bone and do not require subsequent removal. Bone pegs may be freshly made from a bullock's tibia but must be long boiled.

GREENSTICK FRACTURES of the shaft of the femur are only occasionally encountered. If met with they should be carefully bent back into position over a wooden fulcrum by the hands of the surgeon. Complete fractures of the shaft are common and are not difficult of diagnosis.

SIMPLE FRACTURES of the SHAFT of the femur in children are best treated with gypsum cast applied during strong traction under anesthesia with careful manipulative reduction of the fragments, while the child is firmly held upon a pelvic dressing stool (Fig. 166, p. 247) with thigh partially flexed or held at right angle with the body. If reduction is secured at the primary dressing and the fragments fixed while extension is accurate there will be but little tendency to displacement. Hip and knee joints must both be fixed, the spica being carried up to the thorax. If ankle and foot are omitted in the dressing, the surgeon can maintain traction until the cast is firmly set. The continuance of accuracy of adaptation of fragments may be observed by the X-ray during the course of the treatment.

Buck's horizontal extension (Fig. 420, p. 474) and four molded binder's-board short splints and large sand-bags, is the treatment preferred by some surgeons, but this method allows too much movement in a child. If necessary, horizontal weight and pulley extension may be applied beneath a cast at the ankle and lower leg. Zieppinger's automatic continuous extension is effective. If extension is employed, ver-

er and emur.)

n is safest, the pelvis being slightly lifted in order that it counter-extending force.

URES at the LOWER END OF THE FEMUR, the lower frag- tilted directly backward by the gastrocnemius and will n of the tendo-Achillis and careful replacement under ether, peration done. After adaptation of fragments the leg is

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rg., Nov., 1908, 738.
ner. Jour. Orth. Surg., Jan., 1908, 339; Ann. Surg., Mar., 1908; **Davis,** . Surg., Feb., 1909.
., xlviii, 428, 738.
, Univ. Med. Bull., Phil., May, 1908.

dressed with plaster in a slightly flexed position, or is placed on a double inclined plane.

EPIPHYSEAL SEPARATION at the lower end of the femur may be produced by too strong traction on the legs in a head-last labor. It is more common than fracture in children, as union with the shaft does not occur until the twentieth year of life (Fig. 310). Boys stealing rides upon the rear of a wagon frequently fling their legs between the spokes of the wheel and the epiphysis is torn off. The final result is an interference with growth and either a short limb or in-knee or out-knee (Fig. 232, p. 291). The epiphyseal end will be carried forward or backward, according to the direction of the violence. Tilting of the fragments may seriously press upon or obliterate the popliteal vessels and result in gangrene.

An X-ray is of great help and reduction of the fragments by traction and manipulation under ether is of supreme importance.[1]

Retention by gypsum either in slight flexion or judiciously applied in the position that best retains the fragments, will be the most comfortable dressing (Fig. 169, p. 249).

Ashhurst,[2] in giving the results of 61 cases of fracture of the femur, cites thirteen cases treated conservatively with extension, sand-bags and splints in children between two and fifteen years. All recovered with no limp, and in the large majority of cases with perfect functional results. In 121 fractures recorded, 61 were traced later, with the result that while there had been a mortality of 18 per cent. (28 per cent. for neck) yet of the 61 discoverable cases nearly 90 per cent. had recovered with useful limbs. Seventy-eight per cent. had less than an inch of shortening, and of the fractures of the neck of the bone 62 per cent. had good walking limbs. Such results certainly militate against the open treatment either in children or in adults.

In severe injuries, large fragments of bone may be loosened and tilted entirely within the joint, requiring operative removal.

Fractures near the knee are often wrongly diagnosed as SPRAINS. Such a diagnosis is only justifiable by a careful clinical and X-ray examination. Since the introduction of the X-ray many formerly diagnosed internal derangements of the knee are shown to be fractures, a small portion of the tibia or femur being torn away in a so-called sprain of the lateral ligaments. The crucial ligaments if strained may readily displace the semilunars or tear up the bone.

PATELLA.

In the author's collection of 8667 fractures no case of fracture of the patella occurred under ten years of age. This fracture is rare in childhood except from a direct blow. Adhesive strips applied above and below the fragments, and a fixed gypsum dressing with the knee fully extended and thigh continuously flexed upon the pelvis will usually give an excellent result. In adolescents with wide separation of fragments, operative measures are indicated. After injection of the region with 2 per cent. formalin in glycerine, and in a hospital with thorough aseptic surroundings, a frac-

[1] Annals of Surg., July, 1908, 117.

[2] Ashhurst, Annals of Surgery, Nov., 1908, xlviii, 748, 790.

tured patella may be stitched through the capsule with chromicized gut or kangaroo tendon, after removing all clots and blood. Wiring is unnecessary.

Slight voluntary movements should be commenced at four weeks, the splint being daily removed.

TIBIA AND FIBULA.

Fracture of one or both bones of the leg may occur in utero and be united or ununited at birth. These bones also may be broken during labor or in young infants by rough usage or by falls. Occasionally non-union will occur if the fracture is undiscovered (Fig. 280, p. 330).

For infants and young children, after adjustment under ether, a plaster-of-Paris cast fixing thigh, leg and ankle (Fig. 169, p. 249), is decidedly the most comfortable and efficient dressing and allows easy and safe handling or transportation.

Fig. 311. — Greenstick fracture of fibula retaining in place a complete fracture of tibia and masking crepitus.

Greenstick or incomplete fracture of the bones of the leg is common (Fig. 311). After confirmation of the clinical symptoms by an X-ray the lesion in young children should be treated in the same manner as incomplete fracture in other bones by immediate bending into position and retention by plaster splint (p. 305).

Epiphyseal Separation. — The upper epiphysis of the tibia does not unite to the diaphysis until about the twenty-second year of life, the lower at the eighteenth. As this line is mortised (Fig. 312), disjunction only occurs under extreme violence. The tibial tubercle is rarely torn off.

Fig. 312. — Epiphyseal lines of tibia. (Piersol's Anatomy.)

The lower epiphysis is much more frequently separated than the upper and is often mistaken for dislocation of the ankle, especially if fracture or disjunction of the fibula coexists (Fig. 319). Arrest of growth from epiphyseal injury will cause deformity of the ankle with varic or valgic deformity requiring subsequent osteotomy.

Injury to the spongy tissue of the tibia, known as juxta-epiphyseal sprain, is often followed by night pains after undue exercise and denominated "growing pains" in children. Such pains should always be closely investigated as actual lesion of some form is probable (p. 261).

Fractures of one or both bones in the shaft are met with at all ages from infancy to adult life (Fig. 313). Pain, swelling, undue mobility and a moderate amount of crepitus are present when the break is complete.

Fractures of one or both bones of the leg are exceedingly common in childhood, due to the repeated falls and traumatisms incident to the activities of play and work. Compound fractures are frequent from wheels or cars passing across the leg. The protrusion through the skin of portions of bone will require most thorough aseptic cleansings and the removal of

FIG. 313.—Fracture of the tibia in young child.

FIG. 314.—Fracture of tibia and of fibula at different levels.

devitalized fragments. All fragments that promise hopeful prospect of surviving the injury are to be sutured in position with chromicized gut, or secured by screws or plates or wires.

The prospects of saving the limb are much more hopeful in children than in adults, and amputation should not be performed unless the limb is so badly injured that escape from gangrene or extensive sloughing is impossible. Many almost marvelous recoveries can be secured by a clean and careful surgeon.

As soon as a careful clinical examination and the X-ray have determined the character of the lesion (Fig. 314), the fragments are to be thoroughly and carefully reduced, under ether, by traction and manipulation, and the fracture at once fixed by a plaster cast applied as indicated on p. 246 so that it can be readily loosened in case of swelling. Such a dressing is infinitely safer for a restless child than any wooden fracture box or metal or felt splint, with which the patient can meddle. Pain is greatly lessened and the limb can be readily examined.

FIG. 315.—Non-union of tibia after three months.

DELAYED UNION OR NON-UNION of the bones (Fig. 315) is treated by open incision, with fixation of the fragments by metal or ivory screws, or silver plates, or wires or staples, or clamps (Fig. 286, p. 336).

ANKLE.

In fractures of the tibia and fibula near the ankle (Fig. 317), an X-ray should be taken,[1] and the fragments accurately reduced under ether. The foot and leg should then be dressed with gypsum cast fixing the ankle at a right angle (Fig. 316) and slightly adducted, because pronation of the foot is to be avoided. The cast should be slit open upon the inserted metal strip before it is thoroughly hardened (p. 244), thus allowing for expansion and subsequent inspection. With the plaster dressing, early locomotion on crutches is facilitated. As a child's time is of little consequence compared to a perfect result, too early walking upon the cast should not be permitted.

FIG. 316.—Plaster-of-Paris cast fixing ankle in fracture of bones of leg or foot.

The only AMBULATORY TREATMENT that is considered by the author as safe or advisable is on crutches and with plaster cast. Deformity and malunion are such frequent results even with the skilful care of good surgeons, that there is no child with his life work before him who cannot afford to give the necessary period of rest to the healing of a broken limb.

SPRAINS.—Many so-called sprains at the ankle are really fractures of the lower end of the fibula (Pott's) with tear either of the internal lateral ligament, or tearing off of the internal malleolus, or stripping up of periosteum (Fig. 319). If overlooked or inefficiently restored to normal position, union takes place with an obliquity in the valgus position and with marked disability. Subsequent osteotomy with over-correction will greatly benefit such a deformity.

[1] Willard, Skiagraph, Longitudinal Fracture of Tibia, Anna's of Surg., 1897, 763; Fracture and Luxation of Astragalus, Med. and Surg. Reporter, liii, 467, 1885.

Fracture at the LOWER region of the fibula (Pott's) is common in reckless boys (Fig. 318). The early diagnosis is important and the lesion should never be mistaken for a sprain when careful clinical examination under

FIG. 317. — Longitudinal fracture of tibia extending into ankle-joint and permitting backward dislocation of foot.

ether will demonstrate the true result of the accident. The indented deformity and the tenderness at the local injured point should lead to an X-ray examination even though undue mobility and crepitus are absent.

Reposition and fixation in an inverted position of varus will prevent the crippling valgic deformity that so frequently follows and avoid the necessity for subsequent *osteotomy*. Open section is occasionally required for reposition.

FIG. 318.—Pott's fracture at lower portion of fibula with tearing off of internal malleolus, producing the abduction deformity so commonly seen.

FIG. 319.—So-called sprain of the ankle, often the result of loosening of the malleoli at the epiphyses.

FIG. 320.—Hot-air oven, very useful in relieving the induration and stiffening following fractures, especially when followed by massage and gymnastic movements.

Massage after Fractures.—After fractures great benefit will result and the long period of resultant stiffening be shortened by early gentle mas-

sage. This process removes extravasated blood and indurated deposits, diminishes swelling, loosens tendinous adhesions and increases the nutrition of muscles. Its benefit is too much neglected by surgeons.

Later, hot air baking (Fig. 320) and gymnastic exercises, especially in the neighborhood of the joints, will prove helpful in saving much time and obtaining better final results (Fig. 152, p. 235).

FOOT.

Fractures of the foot are frequently compound. With careful antiseptic treatment, amputation can often be avoided and a useful foot secured. Callus and exostoses following fracture of the tarsal bones will give rise to great pain and disability. Any one of the tarsal bones may be broken by falls upon the feet from a great height, and as these injuries were frequently undiagnosed and untreated before the advent of the X-ray,

FIG. 321.—Fractures of the tarsus, the calcaneum being driven forward and upward into the astragalus and scaphoid. Posterior border of os calcis on line with fibula.

serious and prolonged disabilities were frequent (Fig. 321). A radiogram will usually disclose the fracture, and fixation will prevent any undue amount of callus. In some cases, the disabling portion of bone should be removed by operation; in other instances, a supporting plate beneath the arch will give comfort (Fig. 607, p. 704).

A normal epiphysis of the calcaneum should not be mistaken for a fracture (Fig. 322).

The treatment of fractures of the metatarsal bones (Fig. 323) and of the toes does not differ from the same lesions in adults, especially if the fractures are compound. Ether and the Röntgenogram are very important in the diagnosis of all foot injuries. Fixation with plaster cast will soon permit locomotion on crutches.

Skull.—Depressed fractures from p
usually elevate from internal brain press
rhage are evident, trephining should be

Compound fractures of the skull are
Trephining is well borne and recuperat
quently been able to secure excellent r

Fig. 322.—Normal epiphysis of

and retaining fragments even of large si
is advisable. Spicules from the inte
cortex, resulting in subsequent convuls

Nasal Bones.—Fracture of the nasa
as possible into position with an inse
being straightened with flat bladed
strips of adhesive plaster will help to

[1] Willard, Phil. Med. and Surg

be held in place for a week by a sterile harelip pin. Silver or vulcanite tubes in the nostrils will support a broken septum.

Stricture of the tear-duct should be prevented by catheterization.

Fractures of the jaws are treated in the same manner as similar injuries in the adult.

Ribs.—The elasticity of the ribs in childhood prevents fracture except by a severe crushing force which is liable to be fatal.

FIG. 323.—Fracture of first and second metatarsals.

Spine.—Spinal fractures in children are treated upon the same principles as in adults, and need not be separately discussed. The author has been able to secure excellent results in a number of cases of cervical fracture by rigid plaster fixation for many weeks (Fig. 324).

FIG. 324.—Plaster-of-Paris cast for broken neck.

DISLOCATIONS.

Dislocations in children differ so little in their symptoms, diagnosis and treatment from similar injuries in adults that the author economizes space by non-consideration.

Intra-uterine and parturient dislocations are less frequent than fracture under similar conditions.

Congenital dislocations will be discussed in another chapter (p. 721).

CHAPTER XII.

TUBERCULOSIS OF JOINTS AND BONES.

Synonyms: Tuberculous osteoarthritis; white swelling; tumor albus; strumous or scrofulous joint disease; fungous or gelatinous joint disease; caries sicca; spina ventosa; tuberculous ostitis; tuberculous osteomyelitis.

ONE of the most productive causes of deformity is joint and bone tuberculosis. These infections constitute 15 per cent. of all orthopaedic cases. Unfortunately a large majority of these patients come to the orthopaedic surgeon so late that permanent crippling is inevitable and he is able only to partially repair the damage already done by the delay in diagnosis and treatment. About one-third of the cases of bone tuberculosis occur in the spine; at the hip in about the same proportion and in decreasing frequency in knee, ankle, elbow and shoulder. Other authorities place tuberculosis of the spine and hip in a higher proportion. It is evident, therefore, that weight-bearing rather than motion acts as a productive cause in the lower extremity and spine.[1]

Tuberculosis of the joints is so commonly the result of primary tuberculous infection of the epiphyses that practically the conditions can be discussed under the one heading.[2] The exceptions are rare in which primary infection of the shaft or of the ribs or sternum or flat bones or synovial membrane occurs.

Pathology. — The ever present pathological cause of tuberculosis — the tubercle bacillus — gains entrance to the body through the throat, the lungs or the stomach.[3] Direct inoculation through skin or wounds occurs but rarely. The cervical, mediastinal and mesenteric glands are the first sentinels of challenge. These glands may be successful in repelling and destroying the invader, or they may break down and suppurate, and end the process. If the glands fail in their protective office, the bacilli will be carried through the blood current and reach any portion of the body. The embryonal epiphyseal cells are feeble in their resistance and the cancellous tissue of the bone offers a favorable soil for development. Experiments have shown that the injured joints of animals are more liable to be infected with tuberculosis than uninjured ones. It has also been frequently noted that a moderate injury is more productive of tuberculous invasion than a severe one, for the reason that serious injuries probably arouse the resistive power of the area to a more positive degree. A strain upon the ligaments necessarily means a strain also upon the epiphysis, markedly affecting its vascularity.

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[1] Fourth Ann. Report Henry Phipps Tuber. Instit., Phila., 1907, 207.

[2] Nichols, Trans. Amer. Orth. Assoc., xi, 353.

[3] Tuber. in U. S. Bureau of Census, Department of Commerce and Labor, Wash., 1908; Cheyne, Brit. Med. Jour., Apr. 11 and 25, 1891; Fourth Annual Report, Henry Phipps Tuber. Institute, Phil., 1907, 207.

Immediately upon the entrance of the enemy, the repelling elements—the phagocytes—rush to the rescue and surround the foe.[1] The irritation produced invites an accumulation of lymphocytes and protective organisms. If successful in destroying the invader, as is undoubtedly the case in hundreds of instances and especially in normal healthy children, destruction of the bacilli or of their toxins takes place. Should infection be virulent and resistive power feeble, the protective forces may be overpowered and a permanent foothold of disease secured, but the phagocytes still continue the struggle. If they cannot destroy, they will at least envelop and limit the infected area.

The invading bacilli with their poured out toxins, being met by the proliferation of the connective-tissue cells derived from the endothelium and from the cells of the bone marrow, are soon surrounded by the epithelioid and giant cells—karyokinesis. Both endothelial and multinuclear cells possess phagocytic power. A minute grayish mass is soon seen, consisting largely of the cells destroyed by the poisons of the toxins in the conflict- a miliary tubercle; this tiny visible spot or tubercle, containing many microscopic bacilli, quickly becomes yellow. If the conflict continues, the bacilli make their way into surrounding tissues, still meeting with resistance but still advancing. The surrounding area becomes filled with dead cells and the coalescence of numerous tubercles which together with the poorly nourished granulation tissue, steadily advance, destroying the bony trabeculæ (Frontispiece). If the resisting cells are stronger than the invading ones the germs may be destroyed or incapacitated and the centre of the tubercle caseates or calcifies; but if resistance is feeble, a tuberculous bone abscess - cold abscess - may form, or a wedge-shaped sequestrum be produced if an epiphyseal vessel becomes blocked by an infecting mass or bone infarct. A caseating mass, walled in by condensed fibrous tissue, may be so deprived of blood that it will remain quiescent for a long period of time, but its retained dangerous toxins are liable to be awakened into activity and distributed through the system by any subsequent injury or by disease. When caseation - a coagulation necrosis - takes place, liquefaction of the surrounding material will occur, this liquefaction or caseation consisting of serum, fibrin, leucocytes and fragments of bone sand. If abscess forms and evacuates either spontaneously or by operative measures, discharge is likely to continue until all destruction of bone has ceased. The process makes its way from the epiphysis toward the joint, first by a slow destruction of bone tissue, then of cartilage and synovial membrane, until the synovial lymphatics diffuse the poison and the joint becomes filled with granulation tissue of low vitality—the tuberculous pannus. These granulations may break down in cases having low resistance, forming ulcerating areas or pus, or they may loosen the cartilage. True pus formation does not occur except through the introduction of pyogenic organisms. An abscess containing only degenerated tuberculous products seldom yields tubercle bacilli, but its toxins injected into guinea-pigs may produce infection.

[1] Wyeth: Article in Warren-Gould's Internat. Text-book of Surgery, i, 692. Trans. Path. Soc. Phila., xxv, 5 and xv, 15. Jour. Amer. Med. Assoc., Apr. 15, 1899, 1015. Phila. Med. Jour., 1901, 761. International Med. Mag., March, 1900. N. York Med. Jour., June 23, 1900, 1260. Jour. Amer. Med. Assoc., xlvii, 1906, 71.

Granulation tissue under favorable conditions of cell resistance will overcome the tuberculous process by the deposit of fibrinous material favoring ankylosis; or after suppuration may cure by complete fixation. It is remarkable that large destruction of vertebral bone tissue or of the head and neck of the femur may occur without any external evidence of suppuration. Under the destructive advances of the disease the capsule of a joint becomes greatly distended, producing flexion and other deformities, a typical "white swelling." When the invasion occurs in the diaphysis or shaft of a bone the process is very similar in its course, but a tuberculous osteomyelitis is much slower in its progress than an infectious osteomyelitis. The shaft of the bone is less frequently attacked, but in an extensive osteomyelitis (p. 594) an entire bone may be destroyed. Slight traumatisms probably locate the infection in a particular region, yet when tuberculosis is met with in ribs or sternum, some other cause may exist. Such infections frequently arise as a sequence of the lowered resistance through typhoid fever or other exhausting conditions.

A tuberculous osteomyelitis is progressive, while acute osteomyelitis may and often does cease with the death of the shaft and its exfoliation.

Under the X-ray, tuberculous infiltration about a joint will show irregular dark shadows, sometimes enlargement of condyles.

In cases where the primary infection is in the synovial membrane—chronic synovial tuberculosis—the process usually advances more slowly, especially at the knee-joint. Villous proliferations of the synovial membrane, composed of fatty and fibrous tissue, will project into the joint, with peduncles of larger or smaller size. These are usually of firm consistence and unless removed give pain and limitation of motion sufficient to permanently disable the individual.[1] Other results of tuberculous and synovial invasion are seen in the so-called "rice bodies" or small masses of fibrin which may be free within the joint. They are commonly found in tuberculosis of tendon sheaths or bursæ. A peculiar case of tuberculous infection in the region of the pelvis is reported by the author,[2] in which hundreds of small rounded bodies were removed by incision below the groin.

Caries Sicca.—A slow form of joint disease occurring most frequently at the shoulder, is the dry form that tends to atrophic degeneration rather than to suppuration.

The *Bacillus tuberculosis* may be simulated by certain acid-resisting bacteria which implanted in the tissues give rise to lesions suggestive of genuine tuberculosis, but these lesions do not tend to caseation.[3] Their presence in butter and in milk is sometimes confusing if the microscope alone is depended upon, but they may be accidental contaminations. The tubercle bacillus has until recently been considered as an acid-fast or acid-proof bacillus, but recent investigations have shown other bacilli that closely resemble it in morphologic, cultural and experimental peculiarities.[4]

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[1] Painter, Bost. Med. and Surg. Jour., March 19, 1903.

[2] Willard, Trans. Amer. Surg. Assoc., 1900, xviii, 345; Univ. Med. Mag., xiii, Oct., 1900; Trans. Path. Soc., Phila., 1900, 153.

[3] Abbott and Gildersleeve, Univ. of Penna. Med. Bull., June, 1902.

[4] Amer. Med., Sept., 1908, 403.

These altered forms exist not only in bovine and avian tuberculosis but also in lepra, smegma, timothy grass, butter, milk, etc.

Causes.—The tubercle bacillus is the real infective cause of tuberculosis of the joints and bones but other factors may be divided into: (1) predisposing; (2) exciting. The predisposing causes may be either INHERITED or ACQUIRED.

HEREDITY.—At the present time it is thoroughly understood that both predisposing and exciting elements enter into the production of tuberculous joint disease. A TRAUMATISM is the usual EXCITING cause; NON-RESISTANCE of tissues to the tubercle bacillus by heredity or other predisposing elements is the ACTUAL PREDISPOSING cause. The old term scrofulous or strumous, now translated tuberculous, means simply that the individual is born with or acquires a predisposition to feeble resistance of the tissue cells to the attacks of the tubercle bacillus—a condition, not a disease. Grievous errors in diagnosis and in treatment are made by surgeons who argue that a certain joint is not tuberculous simply because they see no evidence of tuberculosis in the parents. In the first place such reasoning is very erroneous; the author has seen both parents of a child with hip disease, die of tuberculosis during the course of the child's treatment, when at the inception both father and mother presented all the evidences of good health and denied any inherited trouble. Parents will both ignorantly and wilfully misrepresent and deceive in regard to the existence of any constitutional taint. Again, robust children of robust parents may become TEMPORARILY NON-RESISTANT from local traumatism or bad hygiene or exhausting disease. The robust child under normal circumstances, however, will overcome the effect of numerous traumatisms, while the child with cells non-resistant through tuberculous parentage will be unable to resist the infection, and will, through slight causes, fall a victim to local tuberculosis. A hereditary syphilitic taint also gives feeble cell resistance.

Heredity, therefore, has nothing to do with DIAGNOSIS, but has great influence upon PROGNOSIS. A fire is a fire wherever seen; a cancer is a cancer, no matter whether parents are thus afflicted or not. Whenever, therefore, a child presents the evidences of tuberculous joint disease, it should be treated upon that basis. The war between Sayre, a supporter of the traumatic theory of joint disease, and the advocates of scrofulosis, arose from the fact that neither party realized that local tuberculosis was possible without general infection and that one condition was a predisposing, and the other an exciting cause.[1] Gross,[2] however, a half century ago wrote, "The appropriate name is strumous, tuberculous or scrofulous hip disease." He also recommended fixation with gutta-percha splint. On the other side, as late as 1886, an enthusiast declared that "hip disease was NEVER connected with a strumous diathesis except by the accident of coexistence."

The exceptions that seem to occur in tuberculosis by inheritance are no more common than are the exceptions of figure, form and characteristics

[1] Colney, Strumous Element in Joint Disease, New York Med. Jour., July, 1877; Watson-Cheyne, Tubercular Diseases of the Joints, p. 97.

[2] North Amer. Med. Chi. Review, July, 1858.

noted in every family; even twins differ greatly. Some children will escape; others succumb. Children of tuberculous parents may escape by immunity, by favorable circumstances or by environment, while children of healthy parentage become infected by contact, by environment, or by lowering of resistive powers either temporarily or permanently. The COMMUNICABILITY of tuberculosis is well established, yet thousands of exposed persons resist the infection. Necessarily the child of tuberculous parents has added to its hereditary lack of cell resistance, the effect of constant contact and environment. While playing on the floor it may breathe dust infected with tuberculous sputum, or carry bacilli into its mouth on the fingers. Added to direct infection will be poor and scanty food, bad air and disease, a most destructive combination.

Heredity does not mean the direct transmission of the micro-organism of tuberculosis from father or mother to child, but the true explanation of hereditary influence is THE TRANSMISSION TO THE CHILD OF AN INHERENT LACK OF CELL RESISTANCE.

Alcoholism and syphilis are undoubtedly large hereditary factors in the production of joint tuberculosis. Drunkenness, even at the time of conception, transmits both mental and physical weaknesses. The habitual users of alcohol usually live in crowded, dark, unhygienic quarters, and as the money required for good and sufficient food is squandered in liquor, the impaired lactation of the mother necessarily leads to defective assimilation and poor nutrition in the child.

Although placental transmission of tuberculosis is rare, yet the chorionic syncytium seems to possess no especial resistance to the tubercle bacillus.[1] The transmission to the child may be either with or without local placental evidences. This question has a definite bearing upon the marriage of tuberculous men and women. Eight cases of tuberculosis are recorded in a family of nine who had for ten years been separated and scattered in six different homes in five different cities in the United States and Canada.[2] Hereditary lack of resistance in these cases would certainly seem more probable than environment or than infection from milk.

All individuals recognize the influence of heredity upon physical and mental traits in horses, dogs and other animals, yet fail to use their intelligence in the selection of a wife or husband, with the result that tuberculous, cancerous, insane and neurotic children are constantly increasing in numbers. Some authors while disclaiming the taint through heredity relate a series of cases showing its influence most positively. If lung tuberculosis could be eradicated in adults the cases of bone tuberculosis in childhood would speedily decrease.

AGE.—Joint tuberculosis in children is rare in the first three months, due probably to the fact that the child is not yet creeping about the floor in the midst of dust and dried sputum; and also, that if milk is given from a tuberculous cow its manifestations would not be immediately observable; however, in Japan, where animal milk is not given to children, tuberculosis is common. When a child is older it puts into its mouth many contaminated substances. The greater vascularity in childhood at the epiphyseal junc-

[1] Warthin, Trans. International Congress of Tuber., Wash., 1908.

[2] New York Med. Jour., Oct. 30, 1908; Amer. Jour. Orth. Surg., Jan., 1908, p. 335.

tions and the greater activity of boys over girls give an explanation of the more frequent occurrence of joint tuberculosis in the former sex. The large percentage of 85 per cent. of joint diseases occur during early years of life and in one-half the cases the inception of the disease is under ten; after fifteen, the cases diminish rapidly.

ENVIRONMENT.—Local environment has much to do with the production of joint tuberculosis. Unsanitary surroundings, bad air, crowded, close quarters, poor and insufficient food are all elements in infection.

CONTAGION.—Living in the same room with a tuberculous patient, especially with a consumptive, eating from the same dishes, and sleeping in the same bed is a very dangerous practice for any child since it must predispose to infection.

Exciting Causes.—TRAUMATISM of a mild degree, especially a strain or sprain in the neighborhood of a joint, is much more liable to be followed by a local tuberculosis than the more severe injuries of fracture or dislocation. This fact may be readily explained by the greater resistance aroused in the local phagocytic cells by the latter.

INOCULATION is rare as a cause, but is occasionally seen. The author recalls the case of an elderly lady in excellent health who was obliged to daily dress the tuberculous abscesses of a child whose mother had died of acquired phthisis. Through an open wound in the finger, infection of her axillary glands occurred with deep-seated suppuration and death.

AUTOINOCULATION, SECONDARY.—Unsuspected tubercle bacilli or their toxins lurking in cervical or mesenteric glands or in any other tissue of the body may act as a direct cause of infection.

BOVINE AND FLY INOCULATION.—The question of infection through the milk of tuberculous cows and the inoculation of bovine virus seems definitely proven through the experiments of Ravenel and others.[1] While milk from tuberculous cows undoubtedly has a large influence in the production of infantile tuberculosis, yet other sources of infection are frequent.

Multitudes of dangerous and unrecognized tuberculous cows undoubtedly exist, and their products, milk, butter, cheese, are all harmful; while their dried feces, so often dusted into the milk, are surely infective.

It is reported that on a single HOUSE-FLY captured upon a pitcher of milk were found 100,000 bacteria. House-flies feeding upon tuberculous sputum have been found to deposit tubercle bacilli in their feces and may also carry on their feet tubercle bacilli from the sputum.

DISEASE.—Acquired local tuberculosis is common from acute disease, as typhoid fever, grippe, measles and other exanthemata, or from any cause that temporarily depresses local resistive power.

Symptoms. The symptoms of tuberculous infection of a joint will be best described under the individual joints. In general they are: (1) limp, (a) brain recognition of pain and the desire to shorten the time of impact; (2) rigidity or muscular spasm from nerve irritation, (3) deformity, first the result of muscular spasm, later from joint changes or destruction; (4) pain, a variable symptom, more or less severe, sometimes localized, sometimes reflected to a distant point, (5) tenderness; (6) heat, in amount

[1] Ravenel, Maryland Med. Jour., xlvii, 63.

dependent on intensity of process and depth of joint; (7) swelling, usually late, from effusion, induration and deposit; (8) atrophy of muscles.

Diagnosis.—It is of prime importance to realize that tuberculosis of the joints is at first a local process and also that local and constitutional signs are often slow in appearing. The conflict going on in the deep recesses of the bone is a quiet struggle but it is a desperate one, and if the surgeon who should have recognized the slumbering embers delays diagnosis until the flame has burst forth so positively as to be visible to a layman, he will have committed a serious injury to his patient. To wait for deformity to establish the diagnosis means irreparable delay. The diagnosis must be made not from pains or tenderness of acute inflammation but from reflex pains and from rigidity of muscles. These are the efforts of nature to guard the joint, the uncertain pain being recognized by the brain of the individual before it is discernible to surgeon or parent. The most serious interference to favorable prognosis and proper treatment lies in the tendency of practitioners to attribute the pain and limping and stiffness, which occur early in joint tuberculosis, to the presence of rheumatism. It is safe to say that nine out of ten cases that come to the orthopaedic surgeon have been treated for months for rheumatism. This careless diagnosis has destroyed more joints and more lives than any other error.[1] When it becomes plainly fixed in the mind of every physician that there is, in children, no such disease as rheumatism of a single joint unless accompanied by fever, pain, swelling and other evidences of acute rheumatism, hundreds of deformities and deaths from joint tuberculosis will be avoided (p. 325).

The clinical symptoms and a careful examination of the bared body and infected joint by an experienced and observent surgeon will usually make clear the diagnosis. Errors usually arise from careless methods of examination.

The RÖNTGEN RAY is a most valuable assistant in the diagnosis of the disease, sometimes enabling the surgeon to discern local foci before the clinical symptoms are sufficiently distinctive for a positive diagnosis.[2] An expert Röntgenographer is essential both for the technic and for the interpretation of the shadow. In interpretation it is very important that the normal Röntgen anatomy of the bones and joints should be known (pp. 7, 8). In early tuberculosis of the epiphysis increase in transmissibility of the rays with slight atrophy of bone will be noticed. In the shaft of the bone, atrophy indicates tuberculosis. A more translucent area will indicate granulation tissue instead of trabeculæ, while a sequestrum will be more dense than normal. In osteomyelitis of the shaft, the X-ray will show necrosis with new bone formation or thickened periosteum. An eroded cartilage presents a ragged appearance. At the hip-joint, not only will the head of the bone or acetabulum show the irregularity of outline but a carious focus in the epiphysis or trochanter may be visible (Fig. 12).

TUBERCULIN TEST.—In some instances the diagnosis of tuberculous joint disease can be established by the HYPODERMIC or the CUTANEOUS test with tuberculin. The serum agglutination test is uncertain. The tuberculin test for joint tuberculosis is not without danger and should not be

[1] New York Med. Jour., June 23, 1906.

[2] National Assoc. Prevention of Tuber., 3rd Ann. Meeting, Washington, 1907, 306.

employed until other clinical and laboratory methods have been exhausted. Its theory is that tuberculous children will show greater reaction than normal ones. In employing the test, skin, syringe and tuberculin should be absolutely sterile. The initial injection should not be more than 0.5 mg. of Koch's old tuberculin, increased to 1.25 mg. to 2.5 mg. or even 5 mg. if necessary in adults. In children 0.05, 0.2, 0.5 to 1.0 mg. is sufficient. If a spurious reaction occurs the same dose is repeated after three or four days. If no reaction is secured the next larger dose is employed. The temperature should be recorded every two or three hours for two days previous to the test and for the same period after the injection.[1] If pulse-rate is increased and the temperature rises two or three degrees after a chill, another test is inadvisable. If the joint becomes swollen, sensitive and tender for several hours, the result is confirmatory of the clinical diagnosis. If only slight reaction occurs, the result may be considered negative. A rise of one degree above the previously recorded temperature is positive, especially if there is a local reaction such as described.

The agent must be used with judgment and discretion and only in non-febrile or weakly febrile and well-selected cases, when clinical symptoms are not positive; if the latter are conclusive, it is better to avoid the use of so powerful an agent. Its indiscriminate use is to be deprecated and both surgeon and pathologist should use judgment.

A positive reaction is more certain in children than in adults, since they are infected less frequently in other areas. If practically every person over five years of age has active or healed tuberculous foci in some region of the body, it is not strange that reactions are readily obtainable.

If a negative result is secured after repeated inoculations the absence of tuberculosis is probable. A reaction may take place in a healthy person from too large a dose or from syphilis or other disease.[2] The hypodermic use of tuberculin both for diagnostic and therapeutic purposes is a more reliable test than the Moro, Calmette or von Pirquet tests, as their results are too often unreliable. The injection method is more accurate (Roth, Schulz) when judgment is based upon both general and local reactions. The use of tuberculin as an aid to diagnosis in joint diseases is unfortunately not as helpful as was at first believed, since reaction may be secured from any distant tuberculous focus, and in children from many causes. Long clinical experience will be the only crucial test of the value of this method. The serum obtained from a blister over a joint is said to be capable of producing a reaction when injected into a tuberculous child.

Cutaneous Reaction by Tuberculin Ointment[3] (Moro).—In this method an ointment consisting of equal parts of tuberculin and anhydrous lanolin is vigorously rubbed into the skin for one minute over an area of two inches in diameter. Papules, nodules, redness and other signs of dermatitis result. Rise of temperature is uncommon. The advantage of the ointment is that it is less harmful than any of the other methods.

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[1] Jour. Amer. Med. Assoc., Dec. 14, 1907, p. 1969.

[2] Muenchener med. Woch., Jan. 14, 1908, lv, 2, 57, 104; Maragliano Serum, Jour. Amer. Med. Assoc., Feb. 22, 1908, 654.

[3] Muenchener med. Woch., Feb., 1908, No. 5; Bandelier and Roepke, Lehr. d. spez. Diag. u. Ther. d. Tuber.

CUTANEOUS REACTION (Von Pirquet). — This method of cutaneous application of a solution of tuberculin is similar to the ordinary operation of vaccination against smallpox.[1] The epiderm is removed without drawing blood, and a drop of pure tuberculin rubbed in. In 24 hours a small elevated papule is visible, followed by a brownish discoloration, edema, and redness disappearing in a few days. Three small areas of skin should be scarified, two being inoculated, while the third is left as a control. In twenty-four or forty-eight hours an elevated papule is called a positive reaction. No rise of temperature, no chill, no systemic disturbance and no unpleasant after effects are expected. If no reaction occurs a second inoculation may be made a week later. In infants, the reaction, if positive, will be visible for a week; in older children, several weeks. This method is especially adapted to children. Practically similar results may be obtained by removing the epiderm in any child and applying an irritant.

The v. Pirquet technic gives fairly reliable results, although positive reactions are sometimes present when autopsies show no signs of tuberculosis. A single positive result is very uncertain.

BOVINE AND HUMAN INOCULATION.—Detre[2] claims that by vaccinating with three separate substances, (*a*) concentrated old tuberculin; (*b*) filtrate of human tubercle bacilli; (*c*) filtrate of bovine bacilli, the source of the infection will be indicated by the respective reactions.

OPHTHALMIC REACTION (Calmette,[3] Wolff-Eisner[4]).—One drop of a half of one per cent. or upon repetition, if necessary, one drop of a one per cent. purified tuberculin in saline solution is dropped into the conjunctival sac of the eye. This procedure is sometimes followed by a violent conjunctivitis, a mucofibrinous exudate and sometimes loss of sight. If any ulceration of the membrane exists, it is especially dangerous and the method is looked upon with decided disfavor by surgeons.[5]

A very important test for tuberculosis is the INOCULATION OF GUINEA-PIGS with the virus.

Blood Count. — In joint tuberculosis, unfortunately, blood counts give but little indication as to the diagnosis. Lymphocytosis is the rule, and the absence of eosinophiles is unfavorable. In mixed infection and in abscess, polynuclear neutrophilic leucocytosis is commonly present and suppurating glands usually yield a lymphocytosis. In cold tuberculous abscess, when the pus is walled in, leucocytosis is not found. In children, pus may exist even when the neutrophiles are as low as 70 per cent. Cytodiagnosis, tuberculin diagnosis, serum and vaccine therapy and the opsonic index require excellent and careful laboratory examinations. The agglutination test for tuberculosis has not proven of early diagnostic value, although it may be used to determine the degree of resistive immunity obtained by

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[1] Wien. klin. Woch., Oct. 1, 1908, 1375; Die Kutane Tuberkulinprobe, Gesellschaft Kinderheilk., Dresden, 1907.

[2] Trans. Sixth Internat. Congress Tuber., Washington, 1908, vol. i, Part i, 515.

[3] Trans. Sixth Internat. Congress Tuber., Wash., 1908, vol. ii, Secs. iii, iv, 542, 581.

[4] Trans. Sixth Internat. Congress Tuber., Washington, 1908, vol. ii, Section iv, 547; Beitrage z. Klin. der Tuber., Bd. ix, Heft 1.

[5] Trans. Internat. Congress Tuber., Wash., 1908, vol. i, 451; Berlin klin. Woch., June 3, 1907; La Presse Méd., Aug. 10, 1907.

the employment of tuberculin treatment. Normal blood has been proven to have extraordinary antiseptic properties.

Dane in the analysis of the blood in fifty cases, with the testing for the opsonic index, shows large variation in results, sufficiently large to indicate that there was no uniformity in the findings. His results in these fifty cases show erythrocytes with an average of five millions, practically normal.

Erythrocytes		5,000,000
Leucocytes		15,000
Hemoglobin	67	per cent.
Lymphocytes	20	per cent.
Mononuclears	8	per cent.
Polymorphonuclears	68	per cent.
Eosinophiles	1.5	per cent.

The red blood-cells varied from 4,200,000 to 7,200,000; the leucocytes from 6000 to 39,000; hemoglobin from 47 per cent. to 89 per cent.

It is claimed that an early diagnosis of tuberculosis may be made by an examination of the blood even before any positive physical evidences are apparent, the red carbol fuchsin stain remaining in the tubercle bacilli while the residue is stained blue by Pappenheim's solution.[1]

Prognosis. — TUBERCULOUS MENINGITIS is the most common cause of death in tuberculous joint disease. The diagnosis is sometimes obscure, as the typical symptoms of headache, sudden cries, constipation and vomiting may one or all be absent. Lumbar puncture (p. 290) and a cytodiagnosis may assist in differentiating the condition from epidemic forms of meningitis, but the prognosis is always grave.

MIXED INFECTION and prolonged suppuration add very largely to the mortality in joint tuberculosis. Waxy degenerations of kidney and other organs and progressive anemia and exhaustion slowly destroy these cases. In a case of suppurative iliac and sacral tuberculosis in an adult, the author saw the temperature chart show daily fluctuations of three to four degrees for one thousand days before death.

It is important that both surgeons and the public should realize that bone and joint tuberculosis is a curable disease, but it requires early diagnosis to ensure excellent results from treatment. Everything depends upon the discovery and abortion of the initiatory symptoms. These symptoms are often obscure and confusing and require close observation. Tuberculosis is no respecter of persons, and a healthy looking child may present to the practiced, observing eye of the surgeon certain slight but essential conditions that are sufficient to establish the diagnosis. The non-discovery or ignoring of these early symptoms through ignorance or neglect or carelessness, is productive of hundreds of cripples. The valuable time that is wasted in the unavailable treatment for rheumatism and a score of other troubles, would have cut short the tuberculous invasion and prevented deformity, caries, ankylosis, suppuration or early death.

The prognosis of tuberculous joint disease will depend upon the virulence of the infection, the promptitude and efficiency of the treatment,

[1] Rosenberger. Am. Jour. Med. Sci., July, 1905, and Feb., 1909. Proc. Phil. Path. Soc., Feb., Paris, 33.

the surrounding conditions of the patient and the lack of resistive power in the individual. As has already been mentioned, the question of hereditary cell resistance has much to do with prognosis, little with diagnosis. Tuberculosis is tuberculosis wherever found. A fire is a fire, whether it be a tiny flame or a conflagration. A healthy child of healthy parents will resist the influence of many a traumatism, while a child hereditarily or temporarily of low resistance will become infected. Many surgeons are prone to decide that a joint disease is not tuberculous simply because no tuberculous history can be traced. This is a most unwise procedure, as tuberculosis may be acquired by any individual and the history of tuberculosis in the parents is absolutely uncertain (p. 371).

It is wise in all cases where the diagnosis of joint tuberculosis is established to warn the parents that a long period of time, from two to five years, must necessarily elapse before a cure can be established. If their minds are prepared in the beginning for such an outlook they are less liable to wander from one surgeon to another.

Vertebral tuberculosis in children requires many years of protective treatment even if paraplegia does not ensue. Spinal caries paraplegia will usually improve within two years and the child will ultimately walk well. Spinal caries in the adult is always serious and if suppuration occurs, usually fatal.

In hip tuberculosis, the mortality under conservative treatment is 20 per cent. from general tuberculosis. Operative treatment does not materially alter this percentage, since nearly 10 per cent. will die from general tuberculosis of lung or meninges, dissemination of the virus having possibly been hastened by the procedure. Whitman states that 25 per cent. of joint tuberculous cases die from tuberculous meningitis or other infection. One-third of the cases of tuberculous joints show tuberculosis of other regions. Koenig puts the mortality in knee tuberculosis at 20 per cent. for patients under fifteen years while for those over forty it may rise to 60 per cent.

In knee or hip tuberculosis, prolonged suppuration or osteomyelitis of the shaft will usually end in death. If protective treatment is delayed in knee tuberculosis without abscess, under ten years, 25 per cent. will die; with abscess 46 per cent.; while in adults the mortality may run as high as 70 per cent. if early amputation is neglected. At the hip, 23 per cent. of cases without abscess die from tuberculous meningitis or other complications under conservative treatment, while 52 per cent. of those with abscesses succumb (see Hip and Knee Diseases, p. 495). Relapses are common in later life, the author having met one case after forty-three years of apparent cure of hip disease. Painter[1] shows that local recurrence rather than metastasis is common.

This terrible showing, with the knowledge that by diagnosis and treatment in the first few weeks of the infection nearly all of these cases could have been saved from noticeable deformity or from death, should cause practitioners to treat even suspicious cases of joint trouble as tuberculosis until it is positively proven that it is otherwise.

A good result in tuberculous joint disease as summed up by Gibney

[1] Painter, Trans. Amer. Orthop. Assoc., 1902, p. 394.

means, a stable limb in good position for sitting or standing, with complete arrest of the disease by hygienic or mechanical measures, by operation, or by abscess formation. Unfortunately, many of the orthopaedic surgeon's best possible results are deformity and lameness, since patients are referred to him only after irreparable damage has been done by delay and long treatment for rheumatism. On account of this delay Cook concludes that about 10 per cent. of the cases of bone and joint tuberculosis, even if treated by open-air life, joint protection and judicious surgical interference, will die either directly or indirectly from tuberculosis; about 1 per cent. from tubercular meningitis, 4 per cent. from abscesses, mixed infection and exhaustion, and 5 to 6 per cent. from extension of tuberculosis to other organs.[1]

Treatment.—The rational line of treatment of all cases of joint and bone tuberculosis must be along the following lines, as adapted to each individual case.[2]

1. To fortify the entire resistive powers of the individual so that the assaults of the bacilli may be successfully repulsed, limited and controlled. Of prime importance for this object is the placing of the child in the direct sunlight as much as possible and living an out-door life night and day with care for every detail of hygiene and sanitation and strict attention to nourishing food and the regulation of habits.

2. To assist the local resistive powers by rest and by mechanical measures, having in view the prevention of added inflammatory factors which would lead to mixed infection and to suppuration.

3. The removal of the diseased focus or of its products by operation, as necessity arises.

The treatment of tuberculosis of joints may be outlined as follows:

1. Abortive.
2. Hygienic and remedial.
   - *a*. Sunshine, fresh air, good food.
   - *b*. Medicinal and local.
   - *c*. Bier's elastic passive congestion.
   - *d*. Tuberculin vaccination with opsonic regulation.
3. Protective.
   - *a*. Rest, fixation and traction.
   - *b*. Mechanical.
4. Correction of early deformity.
   - *a*. Gradual.
   - *b*. Immediate.
5. Operative treatment.
   - *a*. X-ray.
   - *b*. Trephining and ignipuncture.
   - *c*. Aspiration and injection.
   - *d*. Incision, arthrotomy.
   - *e*. Erasion, curetting and drainage.

[1] Cook, Yale Med. Jour., Nov., 1905.
[2] Willard, International Med. Mag., March, 1900.

f. Excision, arthrectomy.
g. Amputation.

6. Treatment of abscesses and sinuses.
   a. Conservative treatment.
   b. Aspiration with injection.
   c. Incision and curetting.
   d. Drainage.
   e. Sinuses, stimulations.
   f. Bismuth injections.

7. Correction of late deformity and ankylosis.
   a. Forcible correction and tenotomies.
   b. Osteotomy.
   c. Excision.
   d. Plastic fascial flaps in ankylosis.

1. ABORTIVE.—The abortion of a tuberculous invasion of a joint is clearly possible if diagnosis is made early. Immediate and complete rest and fixation in the first few weeks as indicated under the following items 2 and 3, will so assist the resistive cell forces that the enemy will be conquered and speedy resolution take place.

2. HYGIENIC AND REMEDIAL.—(*a*) Sunshine and Fresh Air, Open air Treatment.[1]—The most important element in the treatment of bone and joint tuberculosis is the strengthening of the resistive powers of the child. This is best accomplished by the introduction into the blood through the lungs of 25,000 doses of pure air daily, or 4,000,000 to 5,000,000 cubic feet. Compared with three doses daily of drugs that may disturb rather than benefit digestion, there is but little question of comparison [2] (p. 62).

Life in the sunshine as much as possible is essential. Tubercle bacilli die if exposed for a short time to the rays of the sun; they thrive in darkness, filth and confined air. Exposure to the direct rays of the sun of the nude patient or of the bare tuberculous joint[3] alone is helpful in lessening suppuration. Sunshine and oxygen are the two best known agents for destroying these organisms. Many health resorts, as New Mexico, Colorado, etc., owe their efficiency to the excess of sunshine and the number of hours that the patient can be in the open air, rather than to their altitude. Tuberculous joints speedily degenerate when the patient is confined in close, dark, illy ventilated rooms. Cold air inhibits the growth of the bacilli, but does not destroy them. The benefit of cold air lies largely in its effect upon appetite, nutrition, circulation and muscular exercise, with increased hours of sleep. The temperature at zero is not injurious if proper clothing is supplied. The seashore is better adapted to tuberculosis of bones and joints than it is to lung tuberculosis, as many children gain wonderfully

[1] Willard, Open-Air Treatment of Surgical Tuberculosis, Tr. Internat. Congress Tuberculosis, Wash., 1908, vol. ii, 257, Section iii; Sunshine and Fresh Air for Tuberculous Joints, Jour. Amer. Med. Assoc., July 18, 1903; Tr. Surg. Sec. Amer. Med. Assoc., 1880.

[2] A list of the sanitaria, hospitals, day-camps, etc., in the United States and Canada, will be found in 1908 volume of the Russell Sage Foundation Report on Tuberculosis (Jacobs).

[3] Old Dominion Jour. of Med. and Surg., April, 1909.

in the sea air. Perhaps the best combination for joint tuberculosis is the alternation from seashore to mountains. At the seashore even the bathing of sinus cases in the ocean, if they are redressed with sterile gauze after the bath, has been found to be very beneficial. The author has seen cases that seemed absolutely hopeless from long suppuration and amyloid disease of the organs, after a residence at the shore, return with sinuses healed and conditions wonderfully improved. On the other hand, pure mountain air, especially balsam-ladened atmosphere, is equally beneficial. The latest electrical device is an ozone generator for purifying badly ventilated sick rooms so that by the mere turning of a switch, fresh sterilized mountain

FIG. 325.—Shack for open air-treatment of joint tuberculosis. (Carrington.)

air will be at once delivered. The best effects will be secured by an out-door life, both night and day in tent or shack[1] (Fig. 325) or on porch open or roofed (Fig. 326).

In the mountains there is less fog and more sunshine and, according to the altitude, more invigoration. Awnings or screens will avoid the extreme sunlight of summer and fierce winds of winter. Thunderstorms are the most difficult elements to provide against. The disadvantages of the woods for cases on crutches are to be found in the impediments to locomotion by the rough soft ground. For this class surgical sanitaria are needed, separated from medical tuberculosis, where smooth areas for exercise and play can be constructed. Bed-ridden cases can be kept upon gas-pipe or wooden frames (Fig. 362, p. 422) or upon go-carts or wheeled litters (Fig. 364, p. 423) and can then be placed in the open air or kept upon

[1] Burrell, Tr. Mass. Med. Soc., xix, 303; Amer. Jour. of Surgery, July, 1907, 214.

Fig. 320.—Open sleeping porch (Loomis Sanitarium).

the porch night and day. Mechanical fixation and extension can readily be arranged.

It is important, of course, that mechanical and surgical measures shall be in no wise neglected during the open-air treatment, but that rest and fixation of the joint shall be rigidly enforced and if necessary operative procedures shall be added. When desirable, tuberculin bacterin therapy can also be continued (p. 392), or Bier's elastic constriction (p. 388), if suitable.

For the wealthy class, many healthful resorts can be secured, but as a large majority of these cases are poor, efficient treatment in large cities is difficult. With careful education of the mother, and with a wise visiting nurse, much can be done in the improvement of home environments by patiently explaining the benefit of open windows and fresh air. In a close,

Fig. 327. Window tent, with patient's head in open air and body in warm room. Knopf, Kay Scheerer.

illy ventilated room occupied by an entire family, some of them phthisically infected, the effect of environment is soon evident upon a case of joint disease. For these cases hospitals are the only hope of relief. For this reason orthopaedic hospitals are of prime importance in the cities. The State should provide sanatoria in healthful surroundings for surgical tuberculosis separate from cases of medical tuberculosis, with sun porches, solaria, roof gardens (p. 231). Theoretically a canvas tent is excellent, but practically it is very hot in summer and unless floored and partially protected is damp in wet weather. In the winter, if provided with a stove, it is close and illy ventilated. Wooden barracks or shacks are better (Fig. 325). In summer, if a shelter is provided for rain, it is better to sleep in the open, as drafts are thereby lessened. Light wooden cabins or lodges can be inexpensively built. Roofed sleeping porches from the second story of private houses need not be expensive[1] and can be protected by Japanese screens or curtains.[2] Window tents (Fig. 327) are helpful if the patient cannot be removed to other surroundings. An arrangement of window-

[1] Journal Out Door Life, Dec., 1908.
[2] Penna. Med. Jour., Jan., 1906.

sashes by which the patient's bed can b
in Figs. 328 and 329. In houses of the
be exposed by a window with curtains
in the warm room, the head being protec

DAY-CAMPS.—Day-camps accessible
proportion to the amount of time that
the crowded alleys. ROOF GARDENS, p
smoke from chimneys, are excellent sinc

FOREST SCHOOLS with study and rec
service in preventing as well as in curing

FIG. 328.—Outer wall of house windowed so that bed
open porch side

CREATION is truly the result of such t
resistant tissues of the children of the w

The open-air treatment will be su
to the country" where the surroundi
and the food poor, but by careful atte
mechanical and surgical treatment of t

Food.—Food should be easily
eggs, meat and high proteid cereals, o
soup, salads, vegetables and fruit sh
digestive powers; compounds of milk
candy, sweet chocolate should be allo
codliver oil, are helpful if digested. A

from the amount assimilated, not from the quantity eaten, *overfeeding* is harmful. Raw eggs can be best swallowed from a tumbler without breaking the yolks, adding orange juice or salt as preferred. Milk from healthy cows is important. Butter in large quantities, when it can be afforded, is more palatable, of easier digestion and equally as efficient as codliver oil.

(*b*) MEDICINAL AND LOCAL.—Medicines.—Internal remedies may be used as indicated provided they do not disturb digestion. Creosote or guaiacol or iodine given in pepsin are the best. Iron and emulsion of codliver oil with hypophosphites may be given in winter. When a syphi-

FIG. 329.—Sash on outer side of bed closed and inner sash raised, putting patient in warm room for dressing. (Paquin.)

litic taint is suspected, a fraction of a drop of Donovan's solution (liq. hydr. iod. et arsenici), given after meals, alternating each week with a similar dose of Fowler's solution (liq. potass. arsenitis) will be helpful. Succinimide of mercury has been lauded by Wright[1] as a remedy for tuberculosis. It is administered hypodermically in doses for adults of $\frac{1}{4}$ of a grain (0.013 Gm.) daily for fifteen days, then increased to $\frac{3}{4}$ to $\frac{1}{1}$ in adults; children in proportionate doses. The author has for many years administered with most satisfactory results the tonic doses of mercuric corrosive chloride $\frac{1}{3\,1\,0}$ to $\frac{1}{1\,1\,0}$ of a grain in pepsin. The cases are few that will not be benefited by such a course of treatment (see p. 318). The patients most likely to be benefited will be those with syphilitic ancestry. Well-

[1] U. S. Naval Med. Bulletin, July, 1908; Jour. Amer. Med. Assoc., Nov. 28, 1908, 1854.

regulated hygienic measures must, however, not be neglected. Salicylates will sometimes relieve joint pains at night even when there is no suspicion of rheumatism.

Local Counterirritation. — Cataplasma kaolini, ichthyol ointment, iodopetrogen or iodovasogen may be applied to reduce swelling and inflammation. Ichthyol is smeary and its chief benefit lies in the emollient property of the ointment with which it is compounded. Like iodoform, its curative impression upon the mind of the patient lies largely in its unpleasant smell. Iodoform, on account of its vile odor, should never be employed in dispensary or private practice when patients are obliged to mingle with other people.

Iodine in its various forms is the most valuable of all our antituberculous agents. As a local counterirritant, or driven into a joint by cataphoresis or by the red ray, or given internally, or used as an antiseptic in sinuses or abscesses, it is superior to any agent at our command.

Blisters and the Paquelin cautery will often relieve joint pain.

Röntgen Ray Therapy; Radiotherapy and Phototherapy. — The X-ray probably has no direct bactericidal effect upon the tubercle bacilli, as is the case with sunshine, and an exposure sufficiently long to inhibit their growth may result in destruction of healthy tissues. If hyperemia however is desirable, as claimed in the passive congestion treatment, the hyperemia resulting from the stimulation of the X-ray should also be beneficial.[1] The X-rays have been employed therapeutically for tuberculosis as well as for cancer, but the results when unaccompanied by other recognized methods of treatment have not been positive. In the smaller joints of children, however, the process may be retarded. Finsen light therapy is not sufficiently penetrating to reach more than superficial cells[2] (Fig. 330). The high-frequency current has a decided effect upon pain, but does not markedly influence the disease.[3] The direct effect of intense electric light of high candle-power has been employed but its value has not been determined. The direct rays of the sun concentrated through a lens, are certainly advantageous, as the tubercle bacilli are most powerfully inhibited by sunlight and by the hyperemia thus induced. Radium with its marvellous and still unknown qualities, although principally employed in cancerous diseases, has also been used in tuberculosis. "Radio-thor" or "Thorad-x" is a recent candidate for favor. It is claimed that it can be made very cheaply from pitchblende.

Active Congestion. — Active congestion may be accomplished by heat, wet or dry. Many appliances for baking different parts of the body have been devised (Fig. 320), but the results of air superheated to 250 to 400 degrees are more dangerous in tuberculosis than in other diseases of the joints, since infected cells may be distributed by the increased circulation if vigorous massage follows. Simple appliances to cover limbs may be made from wooden boxes lined with asbestos; an alcohol lamp beneath an angulated pipe leading to the box will furnish the heat. For

[1] Pancoast, Nat. Assoc. Prevention Tuber., Wash., D. C., 1907, p. 353.
[2] Light Therapy, Deutsch Aerzte, Berlin, 1902, ii, 361.
[3] New York Med. Times, Feb., 1908.

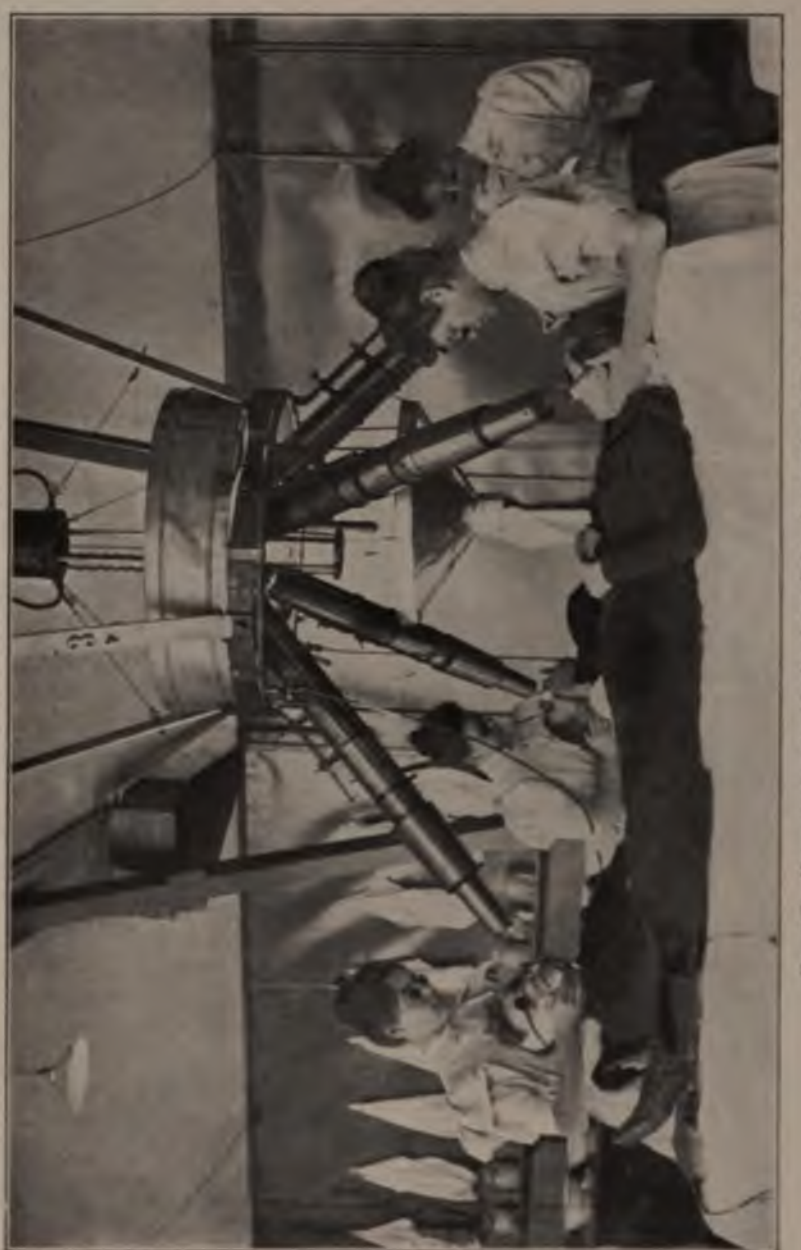

FIG. 339.—Finsen treatment with electric-arc light. (International Clinics, Rio.)

indurations and adhesions following fr
conditions and effusions, stiffened joint
and septic adhesions and a great vari
the superheated air is of the greatest
effused materials, particularly when
passive movements, gymnastic exercise

(*c*) PASSIVE CONGESTION; ELASTIC
UNGS-HYPEREMIA; DRY CUPPING (Bier)
constriction, together with the applicat
recently been largely adopted in Germ
as the stagnation of VENOUS blood pr

FIG. 331.—Elastic band around arm and neck for pr

seemed to be a very rational form
Thomas applied the treatment twent
with a girdle of adhesive plaster to "d
nutrition." Failures have perhaps b
constriction of the rubber bandage o
pressure is the condition to be desire
resistive power to the protective exu
and give in the end a movable joint.
accumulate in the tissues thus prepari
elements. As a result of the hypere
absorbed, but in this increased abso
infection after removal of the band.

[1] Willy Meyer and Schmieden, Passive H
Med. Assoc., 1906; Schmieden, Nat. Assoc. Pre
Orth. Surg., xvii; Bier, xxxv Kongress, Deuts

slight and the time of constriction closely watched and interrupted whenever the interference with circulation gives pain. Gangrene will naturally result if arterial supply is cut off. Close and personal supervision is required and a hospital is the proper place for the beginning of the treatment; but the mother can be taught to treat the child at home so as to produce the proper amount of constriction, and with mechanical protection of the joint, the patient can have the benefit of an out-door life.

The technic is important. A protective bandage beneath the rubber saves irritation of the skin, or elastic webbing bandages may be used. A flannel bandage is sometimes applied to the limb below the joint but is not essential. A broad rubber bandage two and one-half inches wide is applied on the proximal side but at a distance from the diseased joint, each turn

FIG. 332.—Large suction vacuum cup for sinuses at ankle.—Bier.

overlapping the preceding one, but not tight enough to give pain (Fig. 331). The venous but not the arterial circulation must be controlled in order to secure only a bluish-red color and keep the limb warm. Permanent edema and peripheral neuritis or even paralysis may arise from too tight or too persistent constriction. Twice a day for fifteen to thirty minutes is sufficient in children, to be increased as needed. Abscesses are incised antiseptically and curetted (Fig. 332) but not curetted. The suction should at first be applied in children so gently as to give only slight pain, the vacuum being only slightly increased and continued for five or six minutes and then intermitted, to be repeated five to ten times during the day. A year is about the usual time for treatment. Sterile petrolatum is applied during the cupping. In old sinuses connected with tuberculous joint disease, the application of cups to the orifice, together with stimulation of the sinus walls by injections of tincture of iodine, will greatly hasten cure after bone death has ceased. The combination of surgical incision, elastic constriction, cupping and tuberculin vaccine therapy (p. 390) controlled

by the opsonic index, aids in the resistance against inroads of tuberculous invasion in joints to which the method is applicable and yet cases of aggravation of the tuberculous process are not uncommon.[1] The procedure is of greater benefit in acute injuries, infections and phlegmons than in tuberculosis. By this method combined with puncture and cupping, phlegmons are sometimes rapidly relieved of pain and tension, and further suppuration is prevented. Acute joint diseases like gonorrheal arthritis, acute and chronic articular rheumatism, also tenosynovitis, osteomyelitis, and infected wounds, may thus be advantageously treated if combined with usual surgical procedures. Tension must be removed when there is pus, and incision under local anesthesia followed by immediate suction and emptying of the abscess, will greatly relieve the pain.

(*d*) BACTERIAL VACCINE OR BACTERIN THERAPY WITH OR WITHOUT REGULATION BY THE OPSONIC INDEX.—The principle of artificial immunization by the use of tuberculin is somewhat similar to the substitution of vaccinia for variola. Any poison in the human system may stimulate the production of antibodies. Tubercle bacilli undoubtedly produce a toxin which arouses a counterproduction of a resistive agent known as an opsonin and capable of exciting phagocytosis. The theory is advanced that tubercle bacilli are surrounded by a protective envelope which must be removed by the antibodies in the blood and that the child's blood is low in capsule-removing power. ACTIVE IMMUNIZATION is obtained by the injection of increasing doses of the poison; PASSIVE immunization by injecting blood-serum of a previously immunized animal. It is argued that the human system is better able to resist the invasion of tuberculins than it is to ward off the tuberculous toxins which exhaust the patient. The object of the treatment by tuberculin is to increase the natural defenses of the organism, but clinical experience is not yet sufficient to determine its advantages. Tuberculin apparently acts by producing hyperemia in the diseased area with increased leucocytosis, the latter being the chief carriers of bacteriolysins and the chief element in phagocytosis.

The temperature should be taken every three hours both before and after the injection to obtain valuable records of the reaction. The temperature may not rise above 101 degrees but in children with acute infection of joints may rise to 105 degrees. Headache, nausea, chills and vomiting are not uncommon. Local joint reactions are more important than general symptoms, the infected joint often showing swelling and tenderness which may last for one or two days. The temperature usually rises within twelve hours after the injection and falls within twenty hours. Infinitesimal doses graduated to produce a slight or no reaction are much better and safer than violent ones. Hypersusceptibility and anaphylaxis are contraindications to the use of tuberculin therapy. The treatment to be effective must extend over a period of months, sometimes a year.

The PROPHYLACTIC use of vaccines for the elimination of the malign tendency in children of tuberculous parents, may ultimately come into use. Vaccine therapy implies the introduction into the blood of the patient for resistive or immunizing purposes, certain bacterins destroyed by heat, usually suspended in salt solution. These bacterial vaccines or bacterins

[1] Van Kaathhoven, Therap. Gazette, Detroit, Mar., 1908.

may be autogenous, or homologous or stock vaccines, as tuberculin T.R. or bacillen emulsion or bouillon filtrate or the old tuberculin. The purpose of these hypodermic injections is to increase the ingestion and destruction of invading bacteria by the phagocytes,[1] but as the exact nature of opsonins is yet uncertain the methods are still somewhat experimental.[2]

Opsonin is derived from *ὀψωνέω* (I convert into palatable pabulum, or, I prepare a meal for) indicating that the invading bacteria are so influenced by the opsonin produced through the agency of the vaccine serum or bacterin, that the phagocytes are capable of ingesting and destroying them in far greater numbers.

The opsonic index[3] is the measure of the power of the blood-serum of an infected individual to prepare bacteria for ingestion by the phagocytes, as compared with the serum from a healthy individual, or preferably a pool of sera from several healthy individuals.[4] The index of healthy blood is arbitrarily taken as 1. For example, if 100 leucocytes ingest 800 bacteria treated with healthy serum but when treated with the patient's serum the same number of leucocytes take up only 600 bacteria, the patient's opsonic index would be 0.75 (800 : 600 :: 1 : 0.75), *i.e.*, three-quarters of normal. For accurate results the bacteria in at least 100 polymorphonuclear leucocytes should be counted. This index may be raised to a positive phase of improvement by the injection of suitably selected vaccines in minute doses and at intervals of five to ten days. For hypodermic injections the skin should be disinfected with alcohol. The injections may be made in the arm, thigh, back or buttocks. The syringe should have a piston non-perishable by heat, that it may be thoroughly sterilized. After injection the wound should be closed aseptically with gauze or cotton and collodion. The clinical symptoms of malaise, temperature, etc., indicate too large a dose and the negative phase may be exaggerated. The injections should be regulated to maintain the index at or above 1, preferably in the positive phase. Of bacillen emulsion in children .00001 to .00005 mg. is sufficient, or .001 to .0001 mg. of old tuberculin. The vaccine or bacterin selected in tuberculosis may be tuberculin or from staphylococcic or streptococcic or other micro-organisms, or an alternation of two or more of these if there is mixed infection. The proper testing of the opsonic index requires thorough laboratory work.

The advantage to the ordinary practising physician is that he can send his patient's blood or pus to a laboratory in a capillary glass tube and obtain a report as to the probable beneficial vaccine, but the indiscriminate use of bacterins is to be deprecated. A selection of the bacterin or vaccine

[1] Willard, Has the Streptococcus Erysipelatosus an Antagonistic Effect on Local Tuberculosis? Tr. Amer. Surg. Assoc., 1904, 214.

[2] Jour. Amer. Med. Assoc., May 2, 1908, 1390.

[3] Dunham, Annals of Surgery, Oct., 1907, 507; Jour. Amer. Med. Assoc., Feb. 22, 1908, 602; Acad. des Sci., June, 1907; Mathews, Lancet, Sept. 21, 1908; Wien. med. Woch., 1907, 28; Trans. Int. Cong. Tuber., Wash., 1908, II, Sec. IV, 204.

[4] Sir Almroth Wright, London Jour. Amer. Med. Assoc., Aug. 10, 1907; Proc. Royal Soc., Nos. 72, 73, 74; McArthur, Hollister and Lincoln, Surg., Gynecol. and Obst., Oct., 1907; Rolleston, Taylor, Hollister, Amer. Jour. Orth. Surg., July, 1907; McArthur, Trans. Surg. Sec. Amer. Med. Assoc., 1907; Jour. Amer. Med. Assoc., 1908; Surg., Gyn. and Obstet., Oct., 1907; Miller, Univ. of Penna. Med. Bulletin, 1908.

based upon the bacteriological examination of the suppuration is far more trustworthy than if the blood index alone is relied upon. The resistive power of the patient can thus be determined by comparison with normal serum in the laboratory.

As a therapeutic agent in children, the tuberculin treatment is usually employed in chronic cases of joint disease, but unfortunately, in many of the old cases of joint suppuration, there is mixed infection and the injection of staphylococcus and streptococcus bacterin will be required (see p. 393). A low tuberculo-opsonic index with local joint symptoms does not necessarily indicate joint tuberculosis.[1] Operation upon diseased bone is safer if the index is high; more dangerous if low. For specific diagnostic purposes the index seems to be of but little service and clinical symptoms are more reliable. A wise discretion is necessary in the use of bacterins, as in the employment of passive congestive hyperemia, lest the dangerous element of dissemination be introduced. In nearly all cases the judicious employment of surgical measures will hasten cure. The invading foe is to be destroyed not only by the phagocytes but also by increasing the power of the blood fluids which contain antibacterial elements. In the blood fluids we have not only bactericidal and bacteriolytic effects, but sensitizing substances as agglutinins and opsonins. The injection should be made peripherally to the joint to carry it speedily to the locally diseased area by the blood current.

Alternating Bacterin and Tuberculin Therapy.—By alternating pyogenic bacterins with tuberculin inoculations in the author's wards at the University Hospital, Dr. B. A. Thomas has succeeded in the active immunization of cases of mixed suppurative tuberculous joint disease.[2] The method is not applicable to early acute cases nor to late sapremic exhaustions, but chiefly to those with chronic sinus formation. Having ascertained the presence of the *Micrococcus aureus* or *albus* or *Streptococcus pyogenes*, or the *colon bacillus*, or any pyogenic bacterium, an autogenous bacterin is prepared in preference to a stock agent. By culturing and reculturing the suppuration periodically, it may be found that the original bacterium has disappeared and a new infection has been engrafted, demanding a new autogenous bacterin. The preparation of an autogenous vaccine requires good laboratory facilities. Great caution and experienced observation are essential to success, and the treatment may require weekly injections for six months or a year. Dependence for discontinuance or for renewal is to be placed rather upon clinical symptoms than upon the opsonic index, which latter is often misleading. The initial dose of a standardized bacterin is from 4 to 8 minims, containing from 200,000,000 to 800,000,000 bacteria to the cubic centimetre, steadily increased until the temperature falls below 100° F. Inoculations are then commenced with 0.000025 to 0.001 milligrammes of tuberculin, employing bacillen emulsion or bouillon filtrate or a combination of the two. Anaphylaxis from large doses is avoided by administering small but increasing doses approach-

[1] Ridlon, Jour. Amer. Med. Assoc., Jan. 4, 1908; Painter, Boston Med. & Surg. Jour., Oct. 31, 1907, 621; Ross, Canada Lancet, Jan., 1907; Fraser, Glasgow Mar., 1907, 194; Willard and Thomas, Trans. Amer. Surg. Assoc., 1910.

[2] Thomas, Jour. Amer. Med. Assoc., 1909, liii, 897; Trans. Am. Surg. As

ing a maximum of 100 to 1000 mg. in a few cases, but stopping short of intolerant amounts. In inexperienced hands it is a method potent for evil, but with skilled oversight by one who is both a surgeon and a bacteriologist it will assist in curing a dangerous class of cases.

TESTS.—Vaccine or bacterin therapy is to be judged and regulated chiefly by the clinical symptoms, since laboratory examinations from the same case sometimes give variations of 50 per cent. When these methods, however, have been perfected and simplified, the use of these bacterins controlled by the opsonic index will be advisable.[1] They should be combined with fresh air, food, fixation, and when necessary, with operative procedures.

Tuberculin, Old Tuberculin (O.T.) consists of the evaporated products of the bacilli suspended in glycerine.

Tuberculin Residue (Rückstand, T.R.), new tuberculin, is liquid, each c.c. containing 2 mg. of the powder, and is believed to produce an immunity against both toxin and germ.

Bacillen Emulsion (B.E.) does not produce as serious reactions but is believed to secure greater immunity. It contains 5 mg. to each c.c. of glycerine.

Tuberculin (Denys), Bouillon Filtrate (B.F.), is prepared without heat.

It is difficult to fix the size of the doses for children of different ages, but they may be approximately stated as: Old tuberculin (O.T.) dose $\frac{1}{2000}$ to $\frac{1}{1000}$ mg. in children; new tuberculin (T.R.) $\frac{1}{2000}$ to $\frac{1}{1000}$ mg.; bacillen emulsion (B.E.) $\frac{1}{2000}$ to $\frac{1}{1000}$ mg.; bouillon filtrate (B.F.) $\frac{1}{2000}$ to $\frac{1}{1000}$ mg.

Reviere[2] gives the following as the appropriate doses of T.R. for children with localized surgical tuberculosis: $\frac{1}{1000}$ to $\frac{1}{500}$ mg. for a child one year old; $\frac{1}{100}$ mg. for child five years old; $\frac{1}{50}$ mg. for child ten to twelve years old. These doses are not as safe for children as the smaller ones above noted.[3]

Reviere considers that children with surgical tuberculosis are especially benefited by the tuberculin therapy, but the dosage must be exceedingly small and both the clinical symptoms and the opsonic index must be carefully watched in order to regulate the dosage. The general improvement in health of the cases, increase of weight and of appetite, lessening of purulent discharge, and closure of sinuses are the best indications of progress.[4] Miller[5] begins with 0.0000001 gramme doses and increases

[1] Trans. Internat. Cong. Tuberculosis, Wash., D. C., 1908. Amer. Jour. Orth. Surg., Nov., 1908, 341. Amer. Jour. Med. Sci., Aug., 1906, and June, 1907, Best. Med. and Surg. Jour., July 23, 1908. Trans. Nat. Assoc. Study of Tuber., 3d Ann. Meeting, Wash., D. C., 1907. Jour. Amer. Med. Assoc., Nov. 12, 1908, 1750.

[2] Brit. Med. Jour., Oct. 26, 1907. Sahli, Correspondenzblatt für Schweizer Aerzte, 1906, 12, 13. Berlin. klin. Woch., 1906, 43. Deut. med. Woch., 1906, 12.

[3] Reliable standardized bacterins or vaccines are now prepared and sold by reputable firms; not only are the various tuberculins supplied sterile, but staphylo-, strepto-, pneumo-, and gonococcic vaccines are procurable in sealed glass tubes in individual doses, with several progressive dilutions.

[4] A full discussion of the tuberculin treatment and of tuberculin tests will be found in the Transactions of the International Congress of Tuberculosis, Washington, D. C., 1908.

[5] Surg., Gyn. and Obstet., Dec., 1908.

[6] New York Med. Jour., Sept. 5, 1908, 443.

Mouth and Rectal Administration. — The administration of tuberculin (T.R.) and bacterial vaccines by the mouth has not been looked upon with much favor, although tried by Lathan[1] with careful regulation with the opsonic index. The doses are from $\frac{1}{1000}$ to $\frac{1}{20000}$ mg. in saline solution. It is claimed that tuberculin administered by the mouth exercises the same influence as when applied beneath the skin. Tuberculin and Marmorek's serum may be administered by rectum. Marmorek's serum drawn from immunized horses may be used for both diagnosis and treatment in 5 c.c. doses subcutaneously daily for ten days, then intermittently. If not tolerated hypodermically (anaplakynia) it may with equal benefit be employed per rectum.

Maragliano Serum. — Experiments with the two preparations of Maragliano serum, the Liquid F and Bacillary Pulp have seemed unfavorable, but the cases treated have been too few to form any definite conclusion.[2] *Arloing's* and other serums are also employed.

Along the same lines of treatment is the argument in Sajous's "*Internal Secretions*" claiming that immunizing medication is the foundation of rational therapeutics and that bacterial vaccines as well as drugs cause the blood to become richer in thyroidase (opsonin) which prepares the germs and the auto-antitoxin to destroy them. Under the guiding influence of the pituitary body, the adrenals and the thyroid glands supply the material for this germ-destroying process.[3]

3. PROTECTIVE.—(*a*) Rest, Fixation and Traction.—Complete rest and fixation of a diseased joint are of supreme importance during the active and advancing stage of tuberculosis and during all later exacerbations. To be efficient, the rest must be complete and in the lower limbs all weight-bearing positively forbidden. REST in bed during the inflammatory stage must be insisted upon, especially for spine and hip and knee tuberculosis, usually with horizontal extension from head or from foot in order to prevent the mixed infection which is so dangerous an element in tuberculous conditions. Complete rest does not mean simply to keep the child in the house where he will run about the room, concussing the spine or hip or knee hundreds of times in a day. A case of tuberculous joint disease requires MANAGEMENT for years as distinguished from treatment.

(*b*) Mechanical Appliances. — When the patient is ready to assume the erect posture two forms of mechanical appliances are employed; those which produce FIXATION and those which protect by TRACTION. FIXATION can be secured by gypsum, wood, iron, celluloid, felt, binder's board, leather, silicate of soda, starch or other material. Any treatment that attempts to secure motion during the acute stage is injurious. Plaster of Paris properly applied is cheap, comfortable and effective. The articulations above and below the diseased area should be fixed. A plaster-of-Paris cast that extends only three inches above the knee or two inches above the diseased vertebræ is of but little service. The knee cast should extend at least to the perineum (p. 249). In steel many forms of

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[1] Proc. Royal Soc. of London, April, 1908; Lancet, June 6, 1908; Freiberg, Amer. Jour. Orth. Surg., July, 1907; Pozzi-Escot, Toxins, p. 101.

[2] 3rd Annual Report Henry Phipps Institute for Tuberculosis, Philada., 1906, 87.

[3] Taylor, Monthly Encyclopædia Practical Med., vol. x, 3.

apparatus have been devised, more or less helpful in proportion to the degree that they prevent motion in the neighborhood of the diseased focus.

Partial Fixation.—Traction splints have been invented by the scores. They are beneficial in so far as they relieve muscular tension, prevent traumatism and assist in securing rest. Axillary, perineal or ischiatic crutches, with high shoe on the sound side to prevent weight-bearing upon the diseased structures, are essential to success. Protection of the joint must be continued for months, usually for years. A protective splint should not be removed until at least a year after the child is considered absolutely cured. Relapses occur from traumatisms and the splint will assist in preventing such accidents. These various splints will be described under tuberculosis of the several joints.

4. Correction of Early Deformity.—(*a*) Gradual; (*b*) immediate.

(*a*) The gradual correction of the early deformities of joint tuberculosis which are usually in the direction of flexion, will be described under the several joints. In general, it is accomplished by head and foot extension, or by an arched frame for the spine; by horizontal extension in the hip and knee, first in the line of deformity, then slowly coaxed toward normal; or by a progressive series of plaster-of-Paris fixations in improved positions.

(*b*) Immediate Correction. Under ether, a cautious and experienced surgeon can secure great improvement in position when acute symptoms have passed, by carefully straightening the joint to a moderate degree, followed by fixation in the corrected position. At the knee, tenotomy of the hamstring muscles will greatly assist, as will myotomy of the contracted tissues below the anterior spine of the ilium for hip deformity.

5. Operative Treatment.—If operative treatment could remove all tuberculous tissue, it would certainly be the surest and speediest means of riddance, but unfortunately, it is seldom possible to predict that only a single focus exists. Even amputation does not ensure success.

If operative measures do not disseminate the tubercle, benefit is often gained by removal with curette or gouge, or by excising a large majority of the dead and diseased tissue, thus giving to the resistive functions less material to be overcome. In all cases it is evident that cure must depend upon resistance, a fact that is daily being recognized more and more by the profession and is leading to prophylaxis.

a X-ray. An accurate X-ray skiagram may early reveal a focus of disease. Later, the radiogram will be very helpful in diagnosing the amount of bone and cartilage destruction and, in ankylosis, deciding the advisability of attempting to restore motion. If decided destruction of bone is shown, an ankylosis may be the best result obtainable (p. 522).

b Trephining and Ignipuncture.—If the X-rays show a definite focus of disease the trephine or chisel or gouge should be employed to thoroughly remove all invaded bone tissue. The cavity is mopped with pure carbolic acid, then with alcohol, the incision closed with gut and the joint rigidly fixed. The actual or the Paquelin cautery may be used to perforate the focus. The use of the actual cautery in the olden times not only acted as a derivative but it also kept the patient quiet in bed for a long time and was thus of benefit.

(*c*) Aspiration and Injection.— Sterile exploratory aspiration of the fluid and a laboratory examination or the inoculation of guinea-pigs, will assist in treatment as well as in diagnosis. If the fluid drawn is the liquefaction of caseation and is aseptic and sterile, the operation will sometimes be followed by consolidation, caseation and encapsulation. The operation may be repeated as long as the aspirated fluid is sterile. After flushing with 1 to 40 carbolized solution, the injection through the canula of 10 per cent. emulsion of iodoform in sterile glycerine or olive oil is employed by many surgeons, but will usually prove disappointing; it is not germicidal but may stimulate more healthy granulations. In the experience of the author it has not proven as beneficial as tincture of iodine and alcohol, equal parts, or 5 per cent. carbolic acid sterile solution,[1] or Lugol's solution, or formalin 2 per cent. in sterile glycerine, or zinc chloride, or balsam of Peru. Camphor naphthol is no better than iodine.[2] Injections may be made into the joint or directly into the epiphysis. Local resistance may thus be increased by infiltration and by strengthening of the wall of repulsion by additional leucocytosis. The danger of infection during operation will be diminished by chemical infiltration with formaldehyde injections. The protective wall of the cavity should not be fissured by manipulations lest minute openings cause dissemination of tuberculous elements.

(*d*) Incision: Arthrotomy.—In advancing cases, or when pus has formed and the presence of mixed infection is proven, an aseptic exploratory incision is advisable.[3] Bauer more than fifty years ago recognized the serious effect of tension in a joint and advised incision.[4] If marked bone or synovial destruction is found, the more radical operation of erasion or of excision should be performed. For milder cases, an incision with exploration of the joint, flushing with mercuric bichloride 1:3000 or zinc chloride 1 to 5 per cent. or 2 per cent. formalin solution, with closure of the wound and subsequent fixation, will retard or arrest the process.

(*e*) Erasion (incorrectly called arthrectomy), Curetting and Drainage.—*Arthrectomy*, as its name indicates, is the "cutting out" of a joint, namely, an excision or resection. *Erasion*, according to the Standard Dictionary, is, "In surgery, the operation of laying open a diseased joint and removing morbid tissue by scraping (eradere, to scrape out)." It does not seem wise to introduce a new Greek word when the Latin *erasion* thoroughly expresses the idea of "scraping out" of diseased tissues. To maintain uniformity with arthrectomy, arthrotomy and arthrodesis, however, the word arthro-ekkolapsis would be more accurate (ἐκκολάπτω, to scrape out). *Erasion* is an operation; *erosion* is bone destruction. In erasion all diseased tuberculous tissues, both hard and soft, are to be removed with curette and gouge, scissors and knife. Erasion of the soft and hard tissues is a much better operation in children than excision,[5] since it interferes less

[1] Phelps, Cong. Internat. de Méd., Paris, 1900; New York Med. Jour., Sept. 1, 1900.

[2] Mencière, Cong. Français de Chir., 1902, 1907.

[3] Gibney, Amer. Jour. Orth. Surg., Aug., 1909, vii, 1, 22.

[4] Bauer, Orth. Surg., 1854.

[5] Willard, Univ. Med. Mag., Phil., 1890, ii, 359; Internat. Text-Book of Surgery, Warren-Gould, vol. i, 692–713; Jour. Amer. Med. Assoc., Apr. 13, 1901, 1015; Jour. Amer. Med. Assoc., Apr., 1895, xxv, 182; Internat. Med. Mag., Mar., 1900; Univ. Med. Mag., 1890, ii, 359; Ibid., 1893, vi, 162; Trans. Amer. Orth. Assoc., 1893, vi, 23.

with the epiphyseal line. Repeated erasions in ankle or knee or hip in children will often result in an excellent walking limb, or in a movable joint in the upper extremity. After thorough sterilization the part is freely exposed and every focus of disease in the bone reached with the curette or gouge. The operation can be hastened by using a sharp spoon tunnelled longitudinally by a bore $\frac{3}{16}$ of an inch. To this is attached a hose, thus flushing away all diseased material as rapidly as it is scraped and at the same time preventing infection of healthy tissue (Fig. 162, p. 243). The abscess wall is as thoroughly removed as possible, after which the cavity and all freshened cut surfaces are treated with pure tincture of iodine, or pure carbolic acid followed by alcohol, or the edges may be touched with Paquelin cautery. The cavity is filled with sterile carbolized olive oil, or balsam of Peru or glycerogelatin formalin plug.[1] The wound is then closed, dusted with thymol diiodide (aristol) and a sterile compress firmly applied. If pus re-forms the stitches are cut, the cavity injected with formalin and glycerine and a drain tube inserted. In more positive mixed infection and large bone destruction full drainage should be inserted at once, large rubber or glass tubes being employed, or gauze packing. Drainage must be closely watched, the rubber tube removed early and the utmost care exercised to preserve an aseptic condition. The abscess cavity should be irrigated at every subsequent sterile dressing with formalin, bichloride, iodine, peroxide of hydrogen or other antiseptic, the agent being changed every two weeks.

The perfect operation would be the removal of all tuberculous foci, but a partial operation rids the system of a large proportion of the infecting material, thus permitting the repelling forces to attack the remaining organisms with increased hope of success. Unfortunately this operation, the same as excision, has the disadvantage of allowing the tubercle bacilli or their toxins to disseminate through the system, by the opening up of fresh avenues of infection.

Erasion is especially adapted to knee, ankle, tarsus and wrist; excision, to hip, shoulder and elbow. In severe cases, with [illegible] tube drainage and expected ankylosis, FIXATION is secured by plaster of Paris or wooden or wire splints suited to the particular joint. Plaster splints may be made in anterior and posterior halves for removal during dressings by cutting down upon both sides upon a removable metal strip before the gypsum has entirely hardened (p. 644).

Erasion even if several times repeated is the operation of choice in children unless there is extensive bone disease, since it is the operation that removes the least of healthy tissues. Time of operation is of far less importance than growth and if epiphyseal lines are early removed, as in excision at the knee, for instance, a shortening of three to eight inches may result, with a useless limb, while in erasion the ultimate loss will be far less. A recovery with movable joint is somewhat more probable after erasion than after resection. The mortality following the two operations is about the same. The special indications will be discussed under the several joints.

[1] Murphy, Surg., Gyn. and Obstet., Mar., 1908.

(*f*) Excision or Resection or Arthrectomy.—Excision at the present time is reserved chiefly for adults or adolescents; in childhood it is employed in extensive bone destruction and suppuration or when erasion has failed to arrest the caries. In arthrectomy (excision) more healthy tissue is sacrificed than in erasion and the diseased synovial membrane is not as thoroughly removed. In adults and adolescents, after growth is attained, it may often save from amputation and give a useful stiff walking limb in the lower extremity and a movable one in the arm.

The technic of resection is similar to that of erasion, except that larger sections of bone are removed by saw instead of curette. A keyhole, or Butcher's, or amputating or Gigli saw may be used (Fig. 162, p. 243). In children the epiphyseal lines should be avoided if possible, even if small areas beyond must be curetted away. As drainage is to be provided and ankylosis expected, the incisions should be free.

Wiring or nailing is undesirable as the material usually becomes infected and suppuration is prolonged, even if the wires do not require removal. Stitching of fascia or of ligaments with chromicized gut or kangaroo tendon or celluloid thread will temporarily assist in maintaining position, but the chief dependence will be upon the splintage as described under erasion. Rubber tube drainage is usually continued too long, as it prolongs suppuration, but the mouths of sinuses should be kept open until healing occurs. When motion is desired, fixation should cease early.

After arthrectomy in the lower extremities, when ankylosis is desirable, mechanical support to the special joint should be continued for years to prevent relapse from traumatisms.

(*g*) Amputation.—Amputation, especially of a foot or hand, is sometimes necessary in children as a life-saving measure in exhaustive suppuration with amyloid disease. In adults, when time is of importance and where the probability of success by conservative treatment is much less than in children, amputation is frequently necessary.

6. Treatment of Abscesses and Sinuses.—(*a*) Conservative Treatment.—Letting alone is the favorite treatment of abscesses by ultra-conservatives. When there is no mixed infection, resolution, caseation and encapsulation may possibly result. Cold abscess is the term applied to an accumulation of broken-down tuberculous tissue that has slowly dissected its way along lines of least resistance. If no mixed infection has occurred, the contents are serous or whitish, with masses of cheesy débris or curdy flakes of tuberculous necrosed tissue and bone sand. Tubercle bacilli alive or dead can but rarely be detected with the microscope, but the contained toxins will produce tuberculosis in guinea-pigs. The wall formerly called the pyogenic membrane is now known to be the protective wall thrown out as a fortification against the inroads of the disease. A cold abscess may slowly work its way outward for months or even years before opening spontaneously. In pre-aseptic days, to open a psoas abscess was a most dangerous procedure, resulting in mixed infection, prolonged suppuration and death; by present methods such an opening can with the strictest care be kept aseptic for years until the carious vertebral tissue has all been discharged.

For technic of treatment see various joints.

(*b*) Aspiration with injection; (*c*) incision and curetting, and (*d*) drainage, have been already discussed on p. 396. In drainage cases, throughout the entire subsequent treatment of months, the utmost care must be taken to ensure asepsis, since if mixed infection of staphylococcic, streptococcic, pyocyaneus or other micro-organism occurs, there will be long suppuration, exhaustion, and waxy degeneration, which will probably prove fatal. Resident physicians are too apt to consider that because a case is suppurative, less care is necessary as to cleanliness, while the opposite course is requisite since it is the mixed infection that kills.

In abscess cases the continuance of MECHANICAL PROTECTIVE TREATMENT is absolutely important, with the addition of all the OUT-DOOR methods.

BACTERIN THERAPY regulated by frequent bacteriological examinations of the pus and observation of the opsonic index is of particular advantage in sinus continuance (p. 392). Passive hyperemia by the constriction method, with cupping, hot air, etc., is sometimes useful. Deep suture compression of the sinus has also been recommended.[1]

(*e*) In the irrigation of SINUSES a variety of antiseptics are necessary, as the granulation tissue soon becomes accustomed to any stimulant. Tincture of iodine, iothion, bichloride, hydrogen peroxide, formalin, zinc chloride, etc., are valuable, no one of them being employed continuously for more than ten days. Sinuses will remain as long as dead bone exists. When no dead bone is discoverable and sinuses persist in spite of stimulation, curettage and dry cupping over their mouths should be done (Fig. 332) and vaccination under opsonic regulation. Whenever the temperature rises in a suppurative case, diligent search must be instituted in the region of the sinuses; a deeply indurated spot sensitive to pressure will usually be found. Under local anesthesia a free incision should be made, with curettage, carbolic acid mopping and packing. Erasion, or excision, or even amputation is sometimes necessary to remove the carious bone in cases of long standing.

(*f*) Bismuth Injection of Tuberculous Sinuses. Beck[2] has perfected the method of closing old thickened tuberculous sinuses by the injection of bismuth subcarbonate or subnitrate 1 part, vaseline 2 parts. The vaseline is sterilized by boiling. It is then stored in a sterile jar and when reheated the bismuth is slowly added, making a thick mixture. A large syringe with conical point (like a urethral syringe) is used in order to plug the orifice of the sinus. No water must mix with the paste, but cotton dipped in alcohol may be used to cool the syringe. If a stiffer paste is required, 5 per cent. each of white wax and paraffin (melting point 120 degrees) may be added. If there is mixed infection 1 per cent. of formalin is added or one-half of 1 per cent. of powdered iodine. Strong pressure will fill all the ramifications of the sinuses, and with the X-ray, the branchings can be traced (Fig. 333). A sterile pad over the orifice permits slow exudation of the paste. Its healing action seems to be due to the active pressure upon the granulations rather than to any bactericidal

[1] Young, Am. Jour. Orth. Surg., July, 1907, 77.

[2] Emil Beck, Trans. Internat. Congress Tuber., Wash., 1908, vol. ii, 19; Jour. Amer. Med. Assoc., 1909, p. 14; Trans. Amer. Surg. Assoc., 1909.

influence of the bismuth or of the h
upon granulation tissue has been not
benefit results from the injection of
and paraffin 1:8 or even of hot vas
ments inhibit the growth of low
arrests the X-rays. The injections
weeks and speedy closure often occ

FIG. 333.—Long sinus filled with bismuth pa
hip-joint and along inner side of thigh; another
Beck, Int. Clinics.)

exists at the bottom. If the bismu
rarely occur and then only from l
too rapidly in the blood a methe
mucous membranes, a blue line alo
sis, dyspnea, diarrhea, albuminuria
poisoning. Iodine given internally
should be injected into the sinus t
quantities of water must be given

[1] Amer. Jour. Orth.

7. Correction of Late Deformity.—Ankylosis, both fibrous and bony, is a common result of tuberculous disease of the joints. In the spine, firm ankylosis is sometimes the best attainable result; at the hip or knee or wrist in a working boy it is more useful than a feeble flexible joint.

Ankylosis is preventable in tuberculous infections by proper early treatment. If it has already occurred and is caused by inflammatory deposits about the joint, after acute symptoms have passed it may sometimes be benefited by massage and cautious active and passive movements, gymnastic exercises and baking. Firm ankylosis will require first that a radiogram be made to determine the amount of destruction and the advisability of interference.

(*a*) Forcible Correction together with Tenotomies. Brisement Forcé.—Force must be employed with judgment and caution. Where tendons are contracted, preliminary tenotomies are wise. For technic, see special joints.

(*b*) Osteotomy.—Subtrochanteric osteotomy for fixed ankylosis of the femur should not be employed to relieve late deformity until at least a year after the subsidence of all symptoms and the permanent closure of sinuses. A section of the neck with Adams' subcutaneous saw is more likely to arouse fresh infection than the osteotome and also leaves bone dust (technic, p. 492).

Supracondyloid osteotomy of the femur for knee disease is discussed on p. 523.

(*c*) Excision.—Excision of the hip for ankylosis is less frequently done than osteotomy, as a firm lower limb is desirable. At the knee, elbow or shoulder, excision is often of advantage.

(*d*) Plastic Flap of Fascia. Arthroplasty.—Following tuberculous or inflammatory ankylosis at hip, knee, elbow or other joint, the parts may be separated by chisel or by force. Large flaps cut from the neighboring fascia and fat are turned in upon their bases between the two surfaces to prevent readhesion (see individual joints).

Multiple Joint Infection. Occasionally simultaneously, but more frequently in succession, spine, hip, knee, elbow and wrist may become involved, before meningeal or other infection causes death. The author recalls an adult patient whose infection began in one knee, next the opposite hip was involved, then an elbow, then the other knee and elbow, yet after suppuration and amputations of thigh and arm he lived several years. Another case, a healthy looking child, had successive infections for five years, of knee, opposite hip, spine (with paraplegia and laminectomy), with ultimate death from meningitis.

Tuberculous Meningitis. A large proportion of the deaths following tuberculosis of the bones are due to tuberculous meningitis, which is sometimes protective of acute external hydrocephalus (p. 27).

The onset of this condition is indicated by peevishness, loss of appetite, headache and vomiting and rarely by a convulsion. The headache is so severe as to cause the patient to utter sharp, sudden cries. The pupils of the eyes contract, the pulse and temperature are subnormal and constipation is often stubborn. Later, dullness, apathy, convulsions, dilated pupils, strabismus, rigidity of neck muscles, moderate elevation of tem-

perature with low pulse rate are common. The stupor increases to coma, paralysis of various muscles occurs, feces and urine are passed involuntarily, complete insensibility follows and, as death approaches, the temperature rises rapidly. The author in one case noted a temperature of 99 degrees by the mouth and 109 in the rectum just before death of the patient.

LUMBAR PUNCTURE (p. 29) is seldom necessary in arriving at a diagnosis, especially when tuberculous lesions exist in other parts of the body.

The prognosis is always unfavorable. In cases that recover, the diagnosis is always doubtful.

Calomel and bromides seem to be the only remedies promising amelioration. The author has trephined without result. Intradural flushing may be tried.

CHAPTER XIII.

SPINAL CARIES, TUBERCULOUS.

Synonyms: Pott's disease; tuberculous spondylitis; vertebral ostitic arthritis; posterior curvature or angulation; kyphosis; Spitzbuckel; Mal de Pott.

IN THIS scientific age even antiquity does not warrant the designation of this infection by the non-descriptive name of Pott's disease, when both its anatomical location, its pathology and the resultant bone condition are so well expressed by spinal caries, tuberculous—or by tuberculous spondylitis. Moreover, the condition to which Percival Pott especially called attention was spinal caries PARAPLEGIA, which occurs in only a small proportion of cases.[1] The term—SPINAL CARIES—is short and sufficiently

FIG. 334.—Lateral tilt of the trunk from caries of one side of the vertebral bodies. The angulation is abrupt, thus differing from lateral curvature.

distinctive, since there are few surgeons to-day who do not recognize the tuberculous character of the lesion. Even the ancients recognized kyphosis as tuberculous.

Description.—The disease consists in a destructive tuberculous ostitis of the vertebral bodies and intervertebral cartilaginous discs, resulting in a yielding of some portion of the column from caries and superincumbent

[1] Pott, Remarks on that Kind of Palsy Affecting the Lower Limbs, 1779.

FIG. 335.—Carious destruction of bodies of low
and the ribs brought close to the crest of the ilium.
hands hang below the knees.

weight of head and arms with the sequence of a posterior angulation known as KYPHOSIS. If a single body is involved, the knuckle will be sharp; if several bodies yield, the kyphosis will be more or less curved. Occasionally, if the lateral portion of a body gives way a decided lateral angulation will occur, known as LATERAL TILT (Fig. 334) in contradistinction to LATERAL CURVATURE which is an entirely different condition, as elsewhere described

Fig. 33[illegible].—Spe[illegible] showing that marked bony destruction of the vertebræ can take place without any [illegible] Mütter Museum [illegible] College [illegible]

(p. 251). Unless recognized early, cure by ankylosis is seldom effected without more or less kyphosis and the production of the unsightly hump-back deformity with distortion of chest, ribs, and sternum (Fig. 335).

Etiology. The tubercle bacillus is of course the real infective agent, but other causes play an important part. The predisposing causes, HEREDITY, SICKNESS, ENVIRONMENT, CONTAGION, AGE, etc., have been already discussed on p. 372. The *exciting causes*, TRAUMA and DISEASE, are mentioned on p. 373. (For microscopical appearances see Frontispiece.)

Pathology and Course.—The patholo
tuberculous bones and joints (p. 368).
commences in the cancellous tissue of the
—the tuberculous granulations[1] slowly in
teum and then the intervertebral discs an
being but seldom implicated. In childho
bones make the vertebræ especially liable
that the disease must be far advanced be
kyphosis appear, a point that should be
an early diagnosis (Fig. 336). If the tu
ward into the spinal canal, pressure of th
may result in pachymeningitis and in

FIG. 337.—Inability to maintain the erect posture without support even in the early stage of spinal caries and before kyphosis is evident.

ble and extreme kyphosis result without
cure taking place by cicatrization and d
the carious vertebræ.

Location.—The infection attacks
vertebræ, very rarely the sacrum. The
bones most frequently involved.

Symptoms and Examination.—In a
be an increasing peevishness, indispositi
or crying when handled or lifted from
of appetite and colicky pains in abdome
face downward on the mother's lap or sur
and pelvis backward, laterally and forw
or colic or indigestion should always le
for spondylitis. Reflex pains in the side

[1] Spiller, Johns Hopkins Hosp. Bulletin
[2] Med. Ital. Napoli., 1907, 521, 545; D

emergent roots of the nerves are common. A grunting respiration is characteristic of cervical or high dorsal disease and should always lead to an investigation, as should also any irregularity of breathing. Dorsal caries not only gives the abdominal symptoms already mentioned but also gastralgia.

Pains in the limbs are often erroneously attributed to rheumatism, or are called "growing pains." Local spinal pain is increased by pressure on the head, by jumping from a chair, but NOT by pressure on the prominent spinous process. Pains in the genito-urinary organs may also exist

FIG. 338.—Early in the carious process, before deformity is marked, a child will support the spine by resting the hands upon the thighs, in sitting or in standing.

FIG. 339.—The attitude of a child with spinal caries is that of avoidance of motion in the spinal column and a desire for support. The back is always held rigidly.

in dorsal or lumbar spondylitis. Pain down the thighs along the sciatic is common. The position in standing or sitting indicates the weakness of the spinal column (Figs. 337, 338).

MUSCULAR RIGIDITY of the spine is the EARLIEST and the MOST IMPORTANT indication of trouble.[1] This primary rigidity or stiffness is partially voluntary on the part of the muscles, partly reflex and involuntary. If the dorsal or lumbar regions are involved, at a variable time after the reception of an injury the child will be noticed to carry his back stiffly, avoiding motion in any direction, refusing to bend in picking up objects from the floor, preferring to squat and bend the body only from the hips (Fig. 339). The child will often walk upon the toes with knees bent to avoid jar. With the naked child before him the surgeon should carefully

[1] Willard, article, Spinal Caries, Ashhurst's Encyclopædia of Surg., vii, Supplement, pp. 653–667; also Johnson's Universal Cyclopædia, vii, 1895.

FIG. 340.—Backward flexibility of normal spine. Pelvis can be lifted from the table and spine arched backward without discomfort.

FIG. 342.—A child with caries and slight deformity will almost involuntarily seek support to protect the sore vertebræ and prevent motion and attrition.

note the methods of flexion, extension, lateral bending and rotation of the spine as compared with a normal spine with its cervical, dorsal, and lumbar curves. The spine will be carried as a whole either backward, forward or laterally, the diseased portion remaining inflexible. The rigid attitude of the child in standing or walking is characteristic. A rebellious child can often be made to walk toward the mother by sending her to the opposite side of the room. The orthopaedic surgeon should always be provided with toys and candies to beguile the patient into normal movements (p. 13). The child will instinctively carefully guard the spine, avoiding all jars, and for support and rest, the mother or a chair or table will be frequently sought (Fig. 342). After jumping, the child will pause with a troubled expression, then seek relief by resting upon the elbows and in rising the arms will lift the body, using thighs as a fulcrum. When the naked child is laid upon its face on a table and the legs raised, the spine will not arch normally (Fig. 340) but muscular rigidity will firmly fix a certain area (Fig. 341).

FIG. 344.—Cervical and upper dorsal regions held rigidly in commencement of caries in either region.

DEFORMITIES. — KYPHOSIS is a late symptom and indicates a destruction already far advanced. The diagnosis must be made from the much earlier symptoms already detailed, since a diagnosis made after kyphosis is evident means a permanent deformity and perhaps loss of life. The mother can discern the condition after angulation has occurred, but the physician should diagnose and treat the disease long before the deformity appears.

If diagnosis has been delayed until this time, it means that permanent deformity is probable and perfect cure impossible. Progressive tuberculous invasion, bone destruction, muscular contraction and superincumbent weight are then likely to increase the deformity in spite of treatment, particularly if the upper dorsal region is involved. At a variable time after the described initial symptoms, posterior angulation or posterior curvature or kyphosis makes its appearance (Fig. 346). This deformity may be confined to one vertebra or extend over several. Its importance as a symptom will depend upon the coexistent symptoms, chiefly the rigidity. The long curve of a flexible, rickety spine is quite different from the sharp angle of spinal caries and from the long curve of osteo-arthritis in which the column is rigid throughout the entire extent. Irregularity of spinous

processes is not uncommon and th
vertebra or first dorsal should be n
and posterior curves.

When the CERVICAL vertebræ a
head and neck stiffly (Fig. 344), wil
in any direction and will turn the wh
It will frequently have a persistent

FIG. 345.—High dorsal caries with slight kyphosis.

and upper dorsal disease, the respir
and the child steadies the head wit
cervical or first dorsal, paralysis som

The seventh or vertebra promin
that an angulation of the last cervic
only be judged by the accompanyin
dangerous caries of the occipito-axoid
Radiograms will sometimes disclose
presence behind the pharynx may

[1] Mixter & Osgood, A

FIG. 347.—Angular projection of dorsal vertebræ with deformity of ribs. Fixation and permanent ankylosis without suppuration.

FIG. 348.—Hump-back deformity of dorsal region with distortion of ribs and interference with nutrition.

FIG. 349.—Lumbar caries with consequent flattening of dorsal region.

FIG. 350.—Lumbar caries with backward position of spine above the diseased area.

modic cough. The head is tilted ba
shortened (Fig. 343).

The mid-dorsal caries is product
deformity, as the bodies are of mode
shoulders is mechanically serious and
(Fig. 347). The yielding of the bodie
alters the direction of the ribs at thei
forward projections that result in

FIG. 351. — Lateral tilt in the lumbosacral region
dorsal kyphosis.

reflex pains are common. In some
be elicited by pressure or cold or hea
tends to relieve rather than increase t
sitive anterior portion of the verte
muscles in their effort to secure rig
recognition by the brain of impend
neglected symptom. In lumbar carie
dorsal caries in the abdomen, in cerv
distributions of the brachial plexus.

Abscess.—Another late symptom is the appearance of abscess. When tuberculous infection alone exists, the collection is of the variety known as "cold" or tuberculous abscess with liquefying and caseous contents. Such an abscess is often undiscovered for a long period of time.

In the cervical region the pus rarely burrows backward but sometimes makes its way laterally appearing behind the sterno-mastoid. In the majority of cases it passes forward, forming a retro- or post-pharyngeal abscess, which if it bursts spontaneously during sleep, is liable to flood the larynx and drown the patient. If carelessly opened, especially under ether, the same accident may occur. Occasionally it burrows beneath the deep fascia down the neck, or even into the mediastinum or pleura or trachea or esophagus. Difficulty in swallowing and breathing are common symptoms. A fluctuating swelling can be detected by the finger carried to the back of the pharynx.

Fig. 352.—Large pus sacs on both sides of the spine following down the psoas muscles, easily palpable in loins and in iliac fossæ. Such abscesses open either above or below Poupart's ligament. (Mütter Museum, Phila. College of Physicians.)

Fig. 353.—Psoas abscess appearing on inner side of left thigh from dorsal caries.

From the upper or mid-dorsal region an abscess may work forward and break into the pleura or lung or mediastinum, or backward toward the scapula. From the middle and lower dorsal region the course is usually downward within the sheath of the psoas muscle passing through the diaphragm, thence through the pelvis, giving a sausage-shaped tumor in the loin or iliac region with flexion of the thigh (Fig. 352). Sometimes it opens above Poupart's ligament, at other times passes beneath it and opens at any point in the thigh (Fig. 353) even as low as the knee.

From the lower dorsal and lumbar vertebræ the pus may make its way backward to the loin beneath the quadratus lumborum fascia, and

FIG. 354.—Spinal caries abscesses opening backward in loin from dorsal caries. Ilium also carious.

FIG. 355.—Extensive disease of vertebræ, with abscesses in groin and buttocks.

appear below at the outer portion of the erector spinæ group (Fig. 354). Again, it may work its way downward and backward and escape through the sacrosciatic foramen into the buttock (Fig. 355), or into the ischiorectal fossa or rectum, or it may pass forward through the obturator foramen. Abscess results in nearly 50 per cent. of lumbar cases. Abscess contents may be absorbed if there is no mixed infection. The liquefaction of caseation is readily absorbed and the caseous mass may remain quiescent for a long time unless aroused by traumatism.

Paraplegia. — Paralysis of the lower limbs sometimes occurs even before the appearance of spinal deformity. Its first symptoms are fatigue, dragging of the feet, uncertainty of gait and nocturnal incontinence of urine.

Then will follow loss of motion and possibly alteration of sensation. Paralysis of the lower extremities appearing in the course of spinal caries is ordinarily the result of pachymeningitis arising from the presence of tuberculous deposits within the spinal canal. With the thickening of the dura a compression myelitis follows. Occasionally bony angulation adds to this pressure, but a sharply angular kyphosis often exists without paralysis, and paraplegia frequently occurs when the curve is gradual and long. Pus is rarely found within the canal. In severe cases, motor power is entirely lost so that not even a toe can be moved. Knee-jerks and ankle and toe reflexes are increased. The weight of the bed-clothing upon the toes favors contraction of the tendo-Achillis. Spastic rigidity of muscles with atrophy follows. The bladder and rectum lose their contractile power, cystitis and priapism, a persistent and painful erection without sexual desire, follow and bed-sores develop. After an indefinite period, usually one or two years, under proper treatment, an ankylosis is secured, the deposit is absorbed, motor power slowly returns and the patient usually entirely recovers powers of locomotion (Fig. 356). Paraplegia is most common from caries in the upper dorsal vertebræ in which region the canal is smaller. Loss of sensation takes place late and is more rare. Paralysis occurs in about 10 to 20 per cent. of tuberculous spondylitis, depending upon the treatment instituted.

Fig. 356.—This boy was in bed with fixation for more than two years, with spinal caries paraplegia. Motion was entirely lost, he being unable to even move his toes. Sensation was also abolished, knee-jerks and ankle-clonus were both marked. At the present time he is able to walk and run almost normally.

Recording of Deformity.—An outline of the kyphosis for permanent filing can be best made by a lead strip. The child is placed flat upon its abdomen on a table and the outline of the spine molded from the neck to the sacrum. The tracing can then be transferred to card-board to be cut and refitted to the spine, which record will furnish future means of reference. An accurate outline can also be made with Beely's or Young's scoliometer (Figs. 192 and 193, p. 264).

Diagnosis.—The early diagnosis of tuberculous spinal caries is so important for the treatment and prevention of deformity and of abscess with its serious consequences, and of paralysis, that too much importance cannot be placed upon the early symptoms. The infection is frequently treated for rheumatism until kyphosis appears; for pharyngitis when situated in the cervical region; for bronchitis, pneumonia, or pleurisy when in the dorsal; for gastritis, enterocolitis, colic, etc., when in lower dorsal; for appendicitis, nephritis, cystitis, when in the lumbar.

Rigidity and *reflex pains* are so diagnostically important and are present at so early a stage that either symptom should always lead to a

most careful investigation and to treat
sion. Deformity and abscess are so la
is then self-evident.

X-RAY.—While an X-ray shadow
irregular outlines the carious loss of bo
not clearly exhibit the early deposit o
an experienced observer. Pus cavitie
(Fig. 357).

FIG. 357.—Dorsal caries with pus c

TUBERCULIN TEST.—In uncertai
or vaccine regulated by the opsonic
early stage is the only period in whi
limited since it is unimportant after
The variations in temperature in tube

Differential Diagnosis.—RHACHIT
rickety back lacks the rigidity of the
absent, although tenderness of muscle
curve is held rigidly in rickets it is d
of the child is that of weakness rathe
tions of an infant may however be ne

trition, as the beaded ribs and the softened and deformed bones of legs and arms, may also be observed. Spinal caries is rare under eighteen months of age while rickets is common.

LATERAL CURVATURE, SCOLIOSIS.—The deformity of LATERAL DEVIATION or LATERAL ANGULATION in spinal caries is only found when one side of the bodies has crumbled instead of the anterior portion. The bend or tilt is usually in the lumbar region and sharply to the side, differing decidedly from the long curve of scoliosis. If rotation has occurred in the latter condition the prominent posterior thorax on one side seen in the stooping position will appear. Scoliosis is a condition of unbalanced equilibrium, not of bone disease (p. 251).

TORTICOLLIS. — Wryneck will show rigidity in one direction from contracture of the sternomastoid; in other directions the movements may be normal. Lateral carious tilt will give both rigidity and pain on attempts at motion.

ROUND SHOULDERS. — The natural convexity of the upper dorsal region and in other cases its exaggeration, sometimes lead to error if the region is unduly rigid. The absence of symptoms of caries will be the important consideration.

TRAUMA.—The history of an injury and acute local pain and tenderness will be present with possibly inflammatory symptoms and abscess.[1] Except in fracture or dislocation, the kyphosis appears later.

SPRAIN OR STRAIN OF LUMBOSACRAL OR SACRAL LIGAMENTS will be speedily followed by intense pains in back, legs, pelvis and rectum, the pain often being paroxysmal in character, but relieved by the high-frequency current (p. 451).

OCCUPATIONAL STRAINS and injuries in adolescents will usually be temporary, but if muscles or ligaments are torn the disability will be lasting. Kyphosis will be absent, while the onset will be acute and the lumbago sharp in character.

ABDOMINAL TRAUMATISMS.—Rupture or injury of abdominal organs[2] may simulate spinal caries, since the patient will rigidly guard the trunk from jars and movements.

SENSITIVE SPINE.—Sensitive spine is usually found in neurotic patients, pampered children, adolescents or adults. The local pain will be exaggerated; rigidity will be lessened when the attention is engaged. Kyphosis and reflex pains will be absent, although one or two vertebral spines may be prominent. Other hysterical or neurotic signs will be present (p. 449).

NERVE PAINS.—Reflex pains in arms and legs or abdomen should lead to careful investigation of the cause. In sciatica the nerve will be sensitive and pain will be increased by flexion, while in caries, relaxation of the psoas gives comfort.

HIP DISEASE.—In young infants the diagnosis may require several examinations, especially as lumbar caries is suspected, since the latter as well as the spine may be held rigidly even in hip disease. Young's table of [illegible] is an excellent one.[3] In children with a limp,

[1] [illegible]
[2] [illegible]
[3] Young, Orthopedic Surgery, 247.

psoas contraction may lead to a suspicion of tuberculous hip, but the local rigidity in the spine in the one case and the hip-joint muscular rigidity in the other, will lead to a proper diagnosis even if kyphosis has not yet appeared. Later, pus making its way down the limb in front or through the sacrosciatic or obturator foramen may involve the hip and double infec-

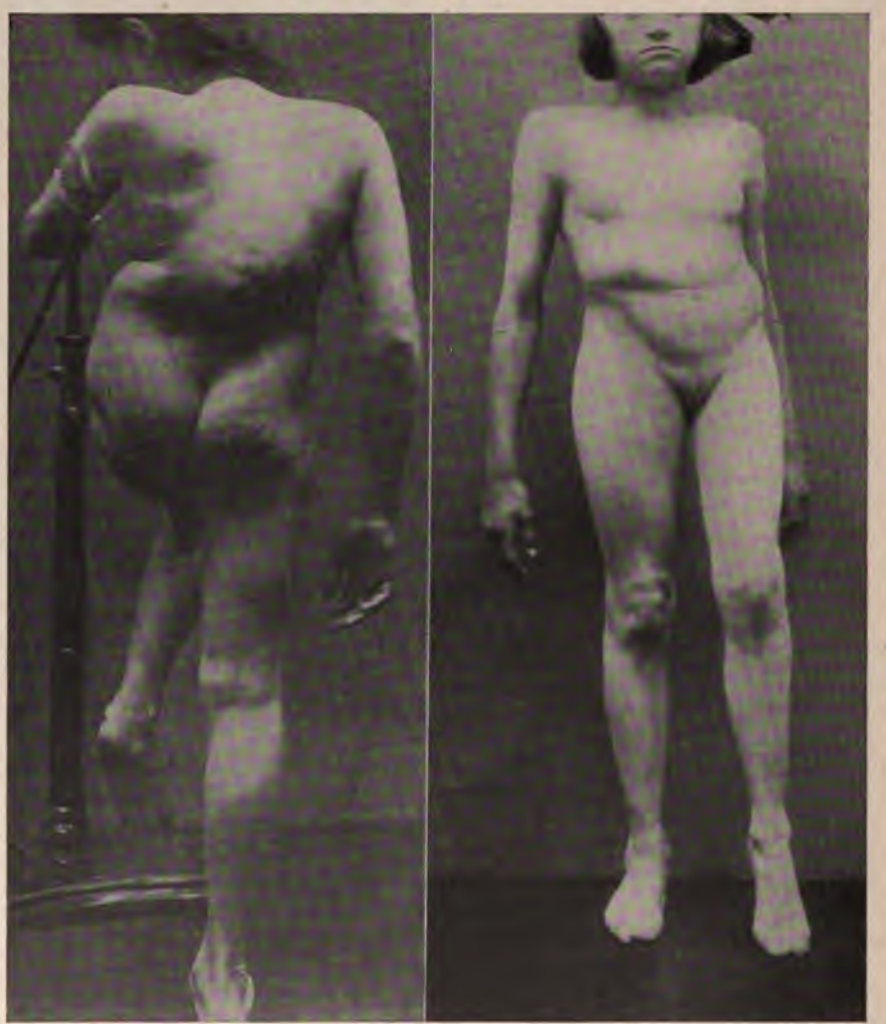

FIG. 358.—Tuberculous disease in both spine and hip, with hip ankylosed at right angle. The inability of the spine to compensate for this lack of motion at the hip, resulted in extreme disability. The second photograph shows the result of a later osteotomy of the femur.

tion occur, or the two infections may occur simultaneously (Fig. 358). When both spine and hip-joint are carious the deformity becomes exceedingly crippling. With pus in the psoas sheath, contraction at the hip will appear, but the muscular resistance to movement of the joint will be only during backward extension, while in hip disease all movements are impaired. The author has seen a spinal abscess present itself just

above the knee anteriorly, yet with scarcely noticeable deformity, the only symptom being a slightly stiff back, while the hip was unaffected (Fig. 349, p. 411).

Sacro-iliac Disease. — Inflammation of the sacro-iliac juncture, often tuberculous in character, will be characterized by increased pain on lateral pressure, by local tenderness and thickening and finally by pus formation, while kyphosis will be absent.

Iliac Abscess.—An abscess in the iliac muscles from forcible tearing of fibres or from an attack of grippe will present the signs of abscess, but not of spinal deformity or rigidity.[1] An iliac abscess from other trauma may also arise.[2]

Pelvic Abscess.—A post-cecal appendiceal abscess may give pain and stiffness but not deformity. In adolescent girls, salpingitis or ovarian abscess will show distinctive symptoms. A psoas abscess from caries may be felt in the iliac fossa as a sausage-shaped swelling long before it appears at Poupart's ligament.

Perinephritic Abscess. — The absence of kyphosis, the localized tenderness, temperature and quickened pulse will lead to full investigation and diagnosis. The author has seen vertebral sequestra make their way into kidney substance.

Fracture or dislocation in the cervical region occurring in young children is not very common, but may simulate either caries or wryneck or lateral curvature. A skiagram will be of assistance. In a unilateral dislocation observed by the author, caused by a forcible twisting of the child's head by the mother in a violent fit of temper, the rigidity and the projection of the transverse processes of the vertebræ upon the convex side were very marked (Fig. 50, p. 70). The head was turned to the opposite side. Movement toward the convex side was impossible but was fairly free toward the concave side. The history was naturally confusing and difficult to obtain and the condition was mistaken at first for swelling of the posterior cervical glands. Strong traction failed to reduce the luxation. In another case seen in adolescence a fracture had evidently occurred from a fall during infancy (Fig. 51, p. 71).

Empyema. — An undiscovered pleural accumulation of pus may make its way backward and be mistaken for a spinal abscess, but the history together with the symptoms will be quite diagnostic.

Retropharyngeal Abscess. — Retropharyngeal abscess formation from caries has been mistaken for diphtheria, for croup and for tonsillitis; mediastinal abscess for asthma. Accumulations of pus can often be located by the X-ray (p. 416).

Typhoid, septic, infectious and gonorrheal spondylitis will be acute in onset and pus formation sometimes rapid. Acute osteomyelitis will be characterized by high temperature, marked constitutional involvement and local tenderness.

Paralyses. If the paraplegia in spinal caries comes on before the kyphotic deformity is discovered, the diagnosis will be obscured. As spinal rigidity is usually absent in other forms of paralysis, the diagnosis can be

[1] Willard, Iliac Abscesses, Non-spinal in Origin, Tr. Phila. County Med. Soc., 1894, 385.
[2] Spellissy, Annals of Surgery, 1893.

cleared by careful consideration of existing symptoms. In ANTERIOR POLIOMYELITIS the rigidity of back will not be present after the first few days, the limbs will be temporarily sensitive and muscle atrophy will follow. Knee-jerks and ankle-clonus will be absent. The distortion of the spine, which appears late in the disease in severe cases of infantile spinal paralysis, is usually lateral, not posterior. The great atrophy of lower limbs, the absence of reflex symptoms and contractures are diagnostic. The late contractions at the hip in infantile spinal palsy are different from the psoas contractions of abscess while spinal rigidity and kyphosis will be found in caries.

CEREBRAL SPINAL PALSY.—The inability of the infant to sit, the curving of the weak spine in any direction, together with the spastic leg muscles and the jerky gait in an older child, the facial expression and other evidences of cerebral deficiency, are sufficient to indicate the condition.

In DIPHTHERITIC PALSY the history will be of importance. Paralysis of the soft palate will usually coexist and spinal symptoms will be absent.

HERNIA.—While the contents of a spinal abscess appearing in the groin may recede on pressure or while lying on the back, yet the slow disappearance of the tumor is entirely different from the slip of a hernia.

MALIGNANT DISEASE OF THE SPINE usually occurs in adults secondary to removal of growths in other regions of the body.

BLASTOMYCOSIS in the early stage may be confusing.[1]

SYPHILITIC SPONDYLITIS in infants is difficult to diagnose from beginning caries unless there are other symptoms of inherited disease. Fortunately both conditions require the same mechanical and general treatment.

OSTEOARTHRITIS, RHEUMATOID ARTHRITIS and SPONDYLITIS DEFORMANS are essentially diseases of adults.

CONGENITAL MALFORMATION OF HIP.—LORDOSIS of the lower dorsal region is sometimes seen in low lumbar caries but is of an entirely different character from the lordosis of congenital hip dislocation. If the child is examined naked, the prominent and displaced trochanters, the waddling gait and the absence of rigidity of the spine will be evident. An X-ray will speedily confirm the clinical symptoms (p. 723).

PULMONARY CONDITIONS.—The irritating cough and grunting respiration will be sufficient to invoke a careful examination both of lungs and spine. Pleurisy and empyema are usually late symptoms in caries from rupture of an abscess. Kyphosis will be present in caries.

Treatment.—The treatment of spinal caries, except as to operative measures, is the same as that described on page 379, q.v.

(1) Hygienic and constitutional measures; (2) rest and fixation; (3) mechanical support; (4) operative measures.

1. HYGIENIC AND CONSTITUTIONAL MEASURES. — (*a*) Out-door Life.—The absolute necessity for tuberculous joint diseases, of an out-door life in pure air, day and night, with good food, has already been discussed on page 380, and need not here be repeated. For the wealthy, the problem is a fairly easy one, but for the poor the difficulties are many. Even in cities, however great, gain is possible when the child can be placed upon a

[1] Brewer, Ann. of Surg., xlviii, 1908, 889.

porch or in a room where windows can be kept open day and night (p. 380). By the use of a bed-frame the problem is made much easier of adaptation to the child's environment.

(*b*) Food.—The feeding of a child is of the utmost importance since nutrition and assimilation are dependent upon normal digestion. Resistance to the inroads of the bacillus is largely influenced by properly nourished tissues (p. 384).

(*c*) Medicine.—Medicines are but of slight importance except those calculated to improve nutritional repellance of the enemy. Codliver oil is extensively used but is not as good as butter in large quantities. Fats are advantageous. Iron, iodine, arsenic, strychnine, etc., are useful. If congenital syphilis is even suspected fractional drop doses of Donovan's solution (liq. hydrarg. iod. et arsenici) are indicated, given in pepsin. Creosote or guaiacol can also be used, but no remedy should be employed that disturbs digestion (p. 385).

FIG. 359.—Head extension by weight and pulley for cervical caries.

2. REST AND FIXATION.—(*a*) Rest is of supreme importance during the acute and painful stage of ostitis. Its influence, as in all other inflammatory conditions, is to prevent injurious motion and weight-bearing upon the sore vertebræ. By its employment pain is relieved, the resistance of the area increased and the danger of mixed infection lessened.

FIG. 360.—Traction forehead and occiput head gear to relieve the jaw from long continued pressure.

(*b*) Recumbency.—During the early stage of spondylitis, rest can be best secured by the recumbent posture upon the bed-frame described on page 422.

(*c*) Head Extension.—Upward extension for cervical and dorsal caries is secured by yoke and head-gear (Fig. 359) with cord playing over a pulley at the head of the bed and weighted SUFFICIENTLY TO GIVE COMFORT to the child. A shot or sand-bag of three to five pounds is sufficient for young children. Circumferential forehead and occipital traction may be substituted (Fig. 360) if it is discovered that the lower jaw is being shortened by too long pressure of the strap. The head-gear (Fig. 361) should be adjusted to bring the greatest pres-

sure upon the occiput. In cervical car
head may be needed.

The child should be placed at some d
bed or it will soon learn to slide up and lo
sion may be made from the feet also if n
straps will prevent rising and turning, or
the mattress with blanket pins. The nu
instructed to turn the child gently on it

FIG. 361.—Traction by spring, with elevation of

bathing, rubbing with alcohol, powdering
since any motion prolongs the period of
patient will recognize that the extensio
and will complain when it is removed.

The canvas-covered galvanized gas-p
Whitman and others (Fig. 362) is of the
spinal cases and at the same time overc
bency, since by its use the patient can be
and can be kept out of doors both day

FIG. 362.—Gas-pipe bed tray, covered with sections of c
cleansing. (Bradford

formity can be maintained and absolut
pletely as on the molded plaster bed used

For an infant, a bamboo or hickory
made so light that without removal the
breast. Brass or steel rods may also be
a little wider than the child and several
employed. The lacings or buckles of the
near the rails (Fig. 363) to prevent the
A space should be left open opposite th
or a third section of canvas may be made
a stretcher can lie upon the bed on the

the frame can be placed upon a wheeled litter (Fig. 364), or baby coach running gear with basket body removed, or on an express wagon, or any set of four wheels (Fig. 365), or it can be carried by two persons up and down stairs, or placed on chairs or trestles upon a porch or lawn.

With proper care and attention this method of extension with out-door treatment can be continued for months, with increasing improvement of health, appetite and nutrition. The recumbent position relieves the bodies

FIG. 363.—Child with spinal caries and kyphosis lying on canvas-covered frame. Temporarily placed in prone position and head extension removed.

of the vertebræ from the deforming superincumbent weight of head and shoulders, abolishes pain and muscular spasm, lessens deformity, promotes ankylosis and hinders suppuration.

If kyphosis has already occurred, its reduction may be commenced as soon as the child has become accustomed to the frame. Two felt pads one-half to three-quarters of an inch in thickness are placed alongside the diseased vertebral spines and sewn to the canvas. Later, the side rods of the

FIG. 364.—Wheeled litter upon which patients can be kept in the open air. Top bed-frame tray removable so that child can be lifted and placed on bed without removing the extension. (Merrill.)

frame are progressively arched to hyperextend the spine backward (Fig. 366) to relieve the carious bodies and throw more weight upon the laminæ.

When the best attainable correction of the deformity has been secured (p. 424), more complete fixation may be gained, when the caries exists in the lower dorsal or lumbar regions, by the application of a light plaster jacket.

The combination of out-door life, recumbency, fixation, extension and correction of deformity on bed-frame and wheeled litter should be continued for not less than three months after the cessation of all pain

and discomfort. Frequently it is wise to continue it for a longer period of time, even for a year if the child is steadily improving in digestion, health, comfort and nutrition.

A plaster-of-Paris bed gives absolute fixation. It is easily made by placing the child in a plaster mold of the posterior half of the body, made

FIG. 365.—Another form of wheeled litter with removable tray, enabling patients to live out of doors.

upon a thin board cut roughly to the shape of the body and legs.[1] Belts or bandages retain it in place and it is easily removed for dressings and cleanliness. In it an out-of-door life is readily secured.

THREE MONTHS OR MORE AFTER THE CESSATION of all acute symptoms, ambulatory treatment may be cautiously commenced, with the aid of a mechanical support to give the child still further advantage of an open-air life.

FIG. 366.—Arched bed-frame for straightening of kyphosis in spinal caries. Felt pads can be used additionally.

3. MECHANICAL SUPPORT TO THE SPINE.—Splinting of the weakened vertebræ is accomplished in two ways: (1) By enclosing the trunk in a splint of plaster-of-Paris, rawhide, leather, celluloid, felt, aluminum, wood, wire, silicate of soda, or starch. (2) By steel spinal apparatus.

[1] Trans. Amer. Orth. Assoc., 1891, iv, 83.

Of these methods no one is applicable to all cases; a judicious discrimination must be exercised.

Plaster Jacket.—The jacket, utilizing the pelvis as a base, aims to protect the diseased area, to prevent motion, to distribute the pressure over the whole surface of the body instead of over limited areas, to support the upper spine by fixing the ribs and converting them into lateral braces, and finally, to correct the deformity by its application to the spine while in a straightened position.

Fig. 367.—Trestles and frame with muslin hammock for application of plaster cast in spinal caries. These trestles are also very useful for support of a frame upon which a patient can be lifted from the bed for dressings of suppurating hip. A basin can be readily placed beneath for irrigation. Muslin tightened by windlass.

Seamless stockinet shirting can be bought by the yard at a low price and is made of different sizes. Beneath this stockinet should be inserted two longitudinal strips of bandage from the head to the thighs, to remain as a permanent cleanser and for carrying in powder or alcohol. The projecting points of the pelvis and the mammæ of girls should be protected by felt pads or by gauze or cotton.[1] Epigastric space for distention of the stomach by food and gas is provided by placing next the skin several layers of gauze folded in the centre of a long towel which can hang over the genitalia during head suspension (Fig. 369), and

Fig. 368.—Gas-pipe frame with windlass at one end for tightening muslin hammock. Correction of kyphosis made by placing patient on abdomen during application of plaster bandage. (Young.)

be withdrawn after the plaster has hardened. A bevelled felt pad is placed over the kyphos. The application of the crinoline bandages is fully described on page 246.

The plaster cast is best applied with the patient lying prone upon a muslin hammock supported upon trestles and rods as shown in Fig. 367.

[1] Gillette, St. Paul Med. Jour., 1905.

The hammock, made of a strip of plain muslin cloth a little wider than the body is fastened at one end and is tightened by the windlass (Fig. 368). The sag of the hammock produces the backward hyperextension of the spine that is desirable in overcorrecting the kyphosis. This method is much more comfortable and less terrifying to a child than suspension (Fig. 369) and permits quiet resting while the plaster hardens. The muslin hammock which has been included in the folds of the bandage is then cut off at either end and remains permanently within the jacket or may be withdrawn. The plaster jacket may also be applied in the position of backward extension by suspending the patient in a muslin sling at the point of the kyphosis, making the shoulders and hips the hyperextending force while the plaster is being applied.[1]

FIG. 369.—Head suspension.

Another method is shown in Fig. 370. The shoulders and pelvis are supported on specially constructed stools with projecting blades, the kyphotic area is elevated by a hinged double plate provided with a screw and raised to the desired hyperextension.[2] The plaster bandages are then applied and when hardened a slit is made over the plate which folds upon hinges and is easily withdrawn, the aperture then being smoothly patched with plaster. The felt pad previously placed over the desired area should be thick on either side of the spine, thinner over the spinous processes and perforated opposite the most prominent gibbus. The jacket also may be applied upon an arched frame in the supine position (Goldthwait) or by the suspension plan (Taylor).[3]

As a rule the casts are made too thick and heavy; one-eighth of an inch is usually sufficient. The pelvic base should be strong and extend low in the rear, a little below the upper border of the internatal fissure (Fig. 371). In front it should be trimmed away sufficiently to accommodate the thighs in sitting. In order to support the anterior chest as high as possible the cast is arched upward from the axilla to reach the top of the sternum (Fig. 372), the axillary portions being subsequently trimmed and bound with adhesive plaster. The tubular stockinet shirting is left long enough to be turned over and sewed on the following day as a complete cover for

[1] Annals Surg., xxiii, 101.

[2] Willard, Tuberculosis of the Spine, Trans. Amer. Surg. Assoc., 1905, xxiii, 100; Ann. of Surg., Oct., 1905.

[3] Taylor, Trans. Amer. Orth. Assoc., xii, 1899, 345.

the plaster and to enclose the neck to prevent the ingress of crumbs. When desirable, the shoulders can be thoroughly fixed and pressed backward by prolonging the jacket to the neck (Fig. 373). Weight can be diminished and strength of cast increased by enclosing in the folds of the bandage longitudinal strips of perforated tin.

If head extension (Fig. 369) is employed the patient should be lifted only on tiptoe, as the struggles of a completely suspended child with weakened spine might be serious. The method is alarming, and is painful to the neck and chin even with padding. If the patient is removed from the swing too soon the jacket may be broken and ruined. The muslin hammock avoids all of these discomforts. The elongation of the patient with straightening of the normal curves by suspension, which has been practised for centuries, is positive though somewhat deceptive, since the actual kyphosis is but slightly altered.

FIG. 370. — Screw elevation for correction of kyphosis during application of plaster cast. Flat spine-plate hinged and removable after plaster has hardened. (Reed.)

FIG. 371. — Non-removable plaster jacket for dorsal caries, for use in dispensary practice.

When the upper dorsal or cervical regions are carious and the head is to be confined, uprights enclosing the head may be incorporated in the plaster. Lateral close-fitting arms or posterior curved bars (Fig. 378, p. 431) with forehead and chin restricting bands or jury-mast may be added (Fig. 374).

FIG. 372. — Plaster cast arched up to clavicles to give backward support to chest in dorsal caries.

A plaster jacket in cleanly persons may be worn for two or three months, and has even been retained for a year. Buttons, pennies, or bread crumbs dropped within, frequently produce ulceration. Any soreness or unusual odor should lead to removal of the cast. A solid jacket is

safest when the child is an out-patient
cheapest and best support; in fact, it is in
ing purposes and reapplication should al
on a table or bed. A REMOVABLE JACKE
when the parents can be trusted to mana
the diseased vertebræ; also in abscess ca
A well fitted and trimmed plaster cast can
throughout its borders with adhesive plast
fastened by flour paste can be used for h
A neater appliance is made by binding t
and riveting two leather strips in front
p. 278).

FIG. 373.—Plaster support of trunk and head

Jackets.—Corsets of leather, silic
plastic felt, celluloid, aluminum, or pape
countercast taken from a mold made in t
ages. Partially tanned leather, molded w
dry slowly for three weeks, then perforate
provided with lacing hooks, makes a neat
a child need weigh but a few ounces (Fig. 2
be recumbent for reapplication. The por
be removed unless ulceration threatens.
are made by orthopaedic surgeons. Sole l
much heavier than the partially tanned lea
but is easily worked by any surgeon. O
now very difficult to obtain. Leather ma
berry wax, or coated with shellac. The le
body mold, then tightly corded with ped
thoroughly dry. Slow drying lessens the

celluloid dissolved in acetone may be fitted to a cast on bandages or on tubular stockinet shirting (see p. 249). When perforated to permit evaporation it is comfortable and light. Sheet aluminum hammered into shape over a metal cast of the trunk, the halves opening by hinges at the back, is light and serviceable. A muslin, wood pulp, glue and paste casing also makes a firm support (p. 250).

To be of service any jacket and corset must support the chest and shoulders as much as possible by being extended in front as high as the clavicles, thus preventing the forward bending of the body and using the ribs as props for the spine. Jackets are very useful in lumbar and lower

FIG. 374.—Jury-mast as applied to plaster or leather jacket for high dorsal or cervical caries.

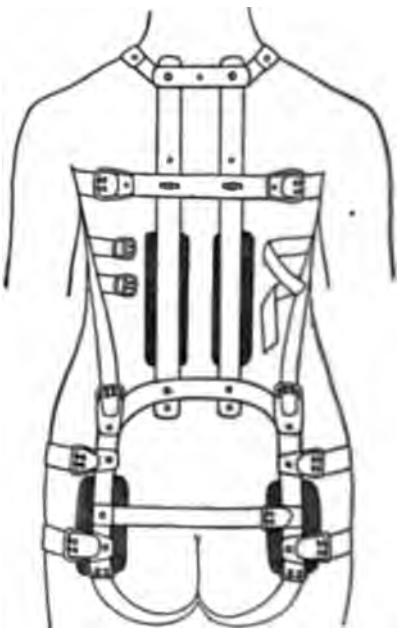

FIG. 375.—Taylor spinal apparatus. "O" shaped pelvic-support, pads on sides of kyphosis, straps to hold shoulders back

dorsal caries, especially with lateral tilt, but cannot support a spine above the level of seventh dorsal or of the lower angle of the scapula. Above this point the superincumbent weight of the shoulders and head must be borne by supports as shown in Fig. 378, p. 431. For the upper spine, steel spinal braces are decidedly better. The great objection to the use of plaster and other jackets arises from the fact that in a large proportion of cases they are improperly adjusted, since surgeons who understand the proper application of gypsum in either joint disease or fracture are decidedly in the minority. All removable jackets as well as steel braces are to be worn day and night. The more accurate the fixation, the greater will be the benefit. Cleansing, alcohol rubbing and powdering must be done without movement of the vertebræ.

Steel Spinal Braces. Another form of support employed by many orthopaedic surgeons for ambulatory purposes is constructed to act

as a lever. It splints the spine from the
head, by two steel uprights one on eith
Shoulder straps or anterior pads prevent
and when the disease is in the upper dors
are prolonged to enclose the head poster
this form of brace is seen in the Taylor ap
service in preventing a deformity, it mu
care being taken when first applied to p

FIG. 376. — Spinal apparatus with circular pelvic band; lateral pads to correct kyphosis. Steel uprights coated with celluloid.

pads of steel
saddler's felt
are attached t
the knuckle a
deformity, bu
watched to p
The uprights c
by coating wit
base of suppor

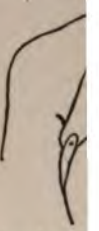

FIG. 377.—Anteri

terior two-thir
trochanters wi
inverted U of
be sufficiently
only by the ad
Gauge 8 to 12
suffice.

In orderin

LINE OF THE

should be taken by metal strip, from th
dorsal or to the sides of the head if th
apparatus. This outline transferred to
fitted to the spine, and the circumference
straps taken. The brace before coveri
celluloid should again be fitted to the s
p. 673). Accurate and complete fixation
pose of all apparatus. If removed on ac
should lie in bed with head extension. If
straps can be added. The pelvic band sh

In caries above the seventh dorsal, hard rubber pads united by a rigid arched bar of steel in front of the humeral heads to force the shoulders backward, may be used, since deformity in this region of the spine is almost certain to be severe unless rigid measures are adopted (Fig. 377).

For cervical and high dorsal, the rigid splint of Bradford (Fig. 378) or the Davis brace is more serviceable in securing the required fixation than the inconvenient and inefficient jury-mast (Fig. 374, p. 429). Forehead and chin adjustable webbing-bands hold the head very firmly in place and are borne more comfortably than a chin rest. The object of all apparatus is not only to splint the spinal column but also to throw the weight as much as possible on the posterior portion of the vertebræ, thus relieving

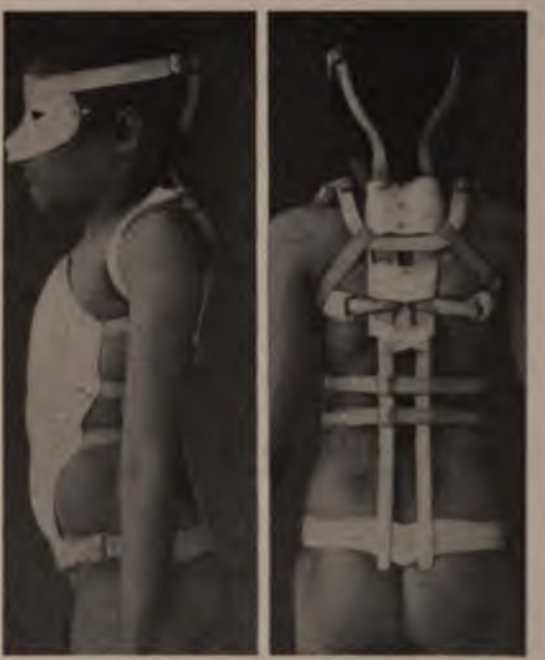

FIG. 378.—Steel uprights extended to head in cervical or high dorsal caries. Forehead, or forehead and chin, support. Steels covered with celluloid. (Spelissy.)

the diseased bodies. The majority of steel braces are held in place by a broad muslin or canvas apron, extending from clavicle to pubis, with five or six non-elastic webbing straps attached to buckles (Fig. 379). The shoulder straps attached to the arched steel arms are tightly buckled to force the shoulders backward.

Neither steel brace nor jacket is applicable to all cases and a wise discretion is necessary for each individual. For cervical and high dorsal caries, a leather collar stuffed with cotton or sawdust, or a thin sheet of plaster or aluminum or celluloid, or a wire frame metal collar adapted to the neck, will prevent motion (Fig. 380). An air-filled rubber collar is more comfortable. Locomotion with head extension may be secured with the aid of the Darrach wheeled crutch. To completely describe the varieties of spinal supports and braces would require a volume.

Treatment, Operative.—The operative treatment of spinal caries may be divided into:

(1) Removal of pus accumulations; (2) removal of carious bone; (3) relief of paraplegia; (4) forcible correction of deformity; (5) wiring of spinous processes.

1. Removal of Pus Accumulations.—Abscesses may be treated by:
   (*a*) Aspiration, with or without injection.
   (*b*) Incision and injection.
   (*c*) Incision, curetting and drainage.
   (*d*) Through-and-through drainage.
   (*e*) Bismuth injections.

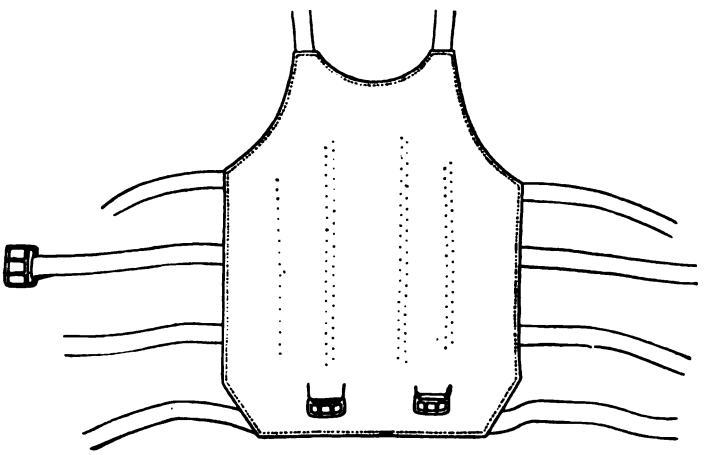

Fig. 379.—Canvas apron for spinal apparatus.

(*a*) Aspiration.—Accumulations either in the back or in the psoas sheath or thigh may be aspirated as an exploratory diagnostic measure. Thorough asepsis of patient, surgeon and instruments is essential, and even with these precautions, tuberculous infection of the line of puncture is apt to follow. This may be partially guarded against by making the puncture in healthy skin, distant from the abscess. If the contents show only liquefaction of caseation, or are sterile as shown by laboratory tests, delay is advisable, as conservative treatment may result in absorption or encapsulation. Repeated aspirations are advisable as long as the contents are sterile. Injections through the canula of one or two drams of tincture of iodine, or of 2 per cent. formalin in glycerin, or of 10 c.c. of iodoform emulsion with glycerin or oil, are helpful.

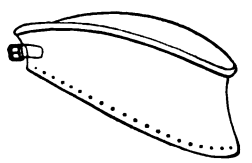

Fig. 380.—Collar for cervical caries.

(*b*) Incision and Injection.—When aspiration proves the presence of mixed infection, incision should be made, the cavity flushed with sublimate solution, injected with tincture of iodine, then thoroughly flushed with alcohol, the raw edges mopped with iodine, the wound closed with continuous sutures and a firm compress applied. If the temperature rises a few days later, the stitches can be cut.

(*c*) Incision, Curetting, and Drainage.[1]—If the cavity can be reached, incision may be free, the limiting wall curetted or cut away with scissors and knife and the whole surface treated with iodine or carbolic acid. A hollow flushing curette (Fig. 162) fed continuously with sublimate solution from an irrigation jar or fountain syringe, is the best prevention against infection of denuded tissues. The cavity should be filled with balsam of Peru and packed with aristolated gauze, or drained. The edges of the skin incision should be thoroughly treated with pure carbolic acid or the Paquelin cautery.

(*d*) Through-and-through Drainage.—In well-defined psoas abscess through-and-through drainage is advisable. The former dangers of "hectic fever" will be avoided by thorough asepsis, continued with most rigid care through all the subsequent months. The most serious fault with many surgeons is the idea that these resulting sinuses following incision need not be guarded and dressed with the same care as a fresh wound. A purely tuberculous sinus will speedily heal after the cessation of bone caries but a sinus with mixed infection will be persistent. For drainage the anterior incision in groin or thigh is made over the most dependent portion of the abscess tumor. Probes eighteen inches long are required, of large diameter, preferably with flat handles (162, *K* and *L*, p. 243) and with eye at the extremity for carrying drainage tube or silk leaders. These should be made of flexible metal in order to be easily bent to the shape of the abscess track. The large terminal bulb prevents injury to the nearby peritoneum. The extremity is cautiously carried upward until it is felt in the loin, when its point can be reached by incision and a large rubber drainage-tube introduced as the probe is withdrawn. If the posterior opening is too close to the crest of the ilium, the bone may be trephined or notched with rongeur forceps. Irrigation by antiseptic solutions is inadvisable for several days lest fissures in the peritoneal wall exist. Hydrogen peroxide should never be used. Sterile dressings should not be removed until odor is noticeable. After the first dressing, the drainage should be replaced by a tube from either end of the track, which tube should be slowly shortened until only the skin openings are held open. Abscess in the iliac fossa may be diagnosed by the sausage-like swelling. In abscesses above Poupart's ligament, the incision should be made so as to avoid the pressure from the jacket. If a psoas abscess burrows beneath Poupart's ligament, the incision is made as far as possible from the urinary organs. Gluteal and obturator abscesses are guided away from infective dangers. Tube drainage is usually continued too long. Prolonged drainage and persistent sinuses are due to the continued presence of diseased bone or to mixed infection or to the neglect of the surgeon to add the essential mechanical fixation of the spine by jacket or brace during all the period of suppuration and for at least a year afterward.

Retropharyngeal Abscess. In the cervical region the most common route for pus is post-pharyngeal. Its presence may be detected by the finger inserted through the mouth. These abscesses should not be opened under anesthesia lest the larynx be suddenly flooded. This danger

[1] Willard, Operative Treatment of Spinal Caries, Trans. Amer. Orth. Assoc., iv, 211; Tr. Phila Coll. Phys., 1889, 74.

may be partially obviated by placing the patient with head lying over the end of the table or by rapid inversion of the body. Pus burrowing laterally or downward may be mistaken for alveolar abscess but may be evacuated behind the sternomastoid or above the clavicle. Pus in the posterior mediastinum is dangerous but can be reached by resecting a rib and transverse process.

Psoas Contraction. — Psoas contraction is often relieved by opening of the abscess, but if persistent it must be corrected by weight and pulley traction progressively applied from the deformed flexed position until restoration is secured. Cautious straightening under ether, with or without open section of fascia and muscles, will be necessary in some cases.

Actual Cautery. — The employment of the actual cautery, so popular fifty years ago, undoubtedly produced its chief benefit by the prolonged rest in bed following its use.

Treatment of Sinuses. — If clinical symptoms indicate a cessation of bone destruction, sluggish sinuses are best treated by laying open the tracks as widely as possible and using a long curette; or by injecting tincture of iodine followed by cupping of the orifice; or by mopping with carbolic acid, chloride of zinc, or corrosive sublimate. Among the newer preparations is iothion, which is rich in iodine, as is also thymol diiodide. For subsequent deep packing, the sheathed packing tube saves pain to the patient.

The repeated injection of sinuses with BISMUTH one part, and sterile vaseline two parts, as advocated by Beck,[1] exerts a direct healing effect upon the granulations, partially by the sterilization of the track, partially by direct pressure or by forming a framework for the new granulations and stimulating their growth, and partially from the direct influence of the vaseline. Sinuses that resist this form of treatment should of course be laid open, bone erasion performed, the sides curetted and cauterized and stimulated with iodine. (For technic see p. 399.) The ramifications of the sinus can be outlined by the Röntgenogram and the bismuth paste, an expedient that will be of the greatest advantage as a pre-operative step. The branches of the sinus will often be found to be very much more extensive and far reaching than suspected and will explain the difficulties of cure that have been experienced under surgical procedures where only a portion of the diseased area has been reached by operation (Fig. 333, p. 400). Iron carbonate or collargol injections may also be used for diagnosis as their atomic weight is greater than that of bismuth. This treatment is especially applicable to cases too complicated to permit of surgical interference.

2. REMOVAL OF CARIOUS BONE — ERASION — ÉVIDEMENT. — The removal of carious bone from a diseased vertebra is a very uncertain operation, since it is impossible to determine that the entire area has been extirpated. In the cervical region the upper vertebræ can be reached through the pharynx, but the operation is inadvisable except through an abscess cavity. Laterally, the lower cervicals may be reached

[1] Jour. Amer. Med. Assoc., 1908; Illinois Med. Jour., April, 1908; Trans. Internat. Congress Tuberculosis, Wash., D. C., 1908, vol. ii, 219; Trans. Amer. Surg. Assoc., 1909; Jour. Amer. Med. Assoc., 1909, p. 14.

posteriorly to the sternomastoid by raising this muscle together with the omohyoid. By dissecting down between the latter muscle and the splenius and through the longus colli, the transverse processes may be felt. The vertebral artery must be avoided and the erasion carefully performed. Sinus tracks should be followed as much as possible.

In the dorsal region, guided by the X-ray skiagram, a long incision may be made to the side of the spinous processes, the ribs and transverse processes being subperiosteally resected to avoid the pleura, the vertebral body gouged or bored and thorough drainage instituted.

The lumbar region is the most favorable one for erasion but even here the advantage gained is problematical as only a portion of the diseased area is likely to be reached. An incision reaching from the twelfth rib to the ilium, two or three inches outside the spinous processes along the border of the quadratus lumborum, is deepened until the transverse processes are reached. The psoas muscle is then separated cautiously with fingers and scissors and a curved bone elevator (Fig. 162, *I*, p. 243) or blunt knife is used to reach the body. The carious bone tissue is then scraped and drainage inserted. A glance at the position of the vertebral bodies in their relation to the trunk will show the depth of the diseased process and the difficulties to be encountered (Fig. 381).

Fig. 381.—The bodies of the lumbar vertebræ extend far forward into the abdominal cavity. (Piersol's Anatomy.)

3. Relief of Paraplegia.—(*a*) Long-continued extension; (*b*) laminectomy or trephining of the spine; (*c*) forcible straightening.

(*a*) Extension long continued has been discussed on p. 122.

(*b*) Laminectomy. Laminectomy is a hybrid word, but is expressive and accurate, and is therefore better than the Greek elasmectomy.

Removal of the lamina should not be practised until fixation and long-continued extension on a frame in the open air have been thoroughly tested for two years, as the majority of cases will recover the use of their limbs under well-conducted treatment for this length of time (see p. 123). If the caries existed in the lamina the operation would be helpful, but since the bodies are chiefly at fault, and as ankylosis is the only ultimate means of cure, the removal of the posterior supports weakens

the spine at a vital point. As pressure
deposit within the canal and to pachymen
removal of arches can only relieve the pre
results obtained in certain cases unfortu
majority of operations and relapses are fr
lous deposits may occur. In the dorsal
but in the lumbar region the great dep
makes the operation a formidable one an
tion from incontinence of urine and fe
should be taken obliquely. The patient

FIG. 382.—A celluloid turtle-shell support is the bes
convalescing paralytic cases. This boy after a total p
plegia for three years was finally able to walk without sup

The removal of the first lamina is t
vertebral ligament and fat are pierced
lations must be cautious. Hemorrha
veins is troublesome. When once the
laminæ can be rapidly divided with s
P, p. 243), with lower blade flat and pe
the base so that it does not become i
lous material should then be cautiou
intact if the cord pulsates. If carious b
it may be scraped away. The chief be
from posterior pressure. If thorough a
orrhage arrested, the skin may be ligh
gauze inserted until the first dressing.

a water bed in a plaster cast. Mechanical support must be worn for years (Fig. 382).

Relief of the paralysis is sometimes speedy if caused only by tuberculous masses, but in the majority of cases improvement is tardy and uncertain and relapses are common. The mortality from the operation is about 25 per cent., and, if the cases dying within the first year from subsequent complications are included, it is probable that nearly one-half have their life abridged rather than lengthened by the laminectomy, a strong argument in favor of prolonged rest, fixation and extension. Including deaths and cases not materially improved the non-successful cases reach about 65 per cent.[1] The operation therefore is of benefit only in well-selected cases where conservative treatment has failed after two years of thorough trial, and where sodium iodide given in pepsin, or Donovan's solution, tonics and arsenic in small doses have been long continued. If sensation is lost, early laminectomy is advisable. Relapses of paralysis while discouraging are not hopeless. Laminectomy is a tedious and difficult operation both for patient and for surgeon.[2] Hemorrhage in and around the cord may give secondary symptoms. After operation extension to legs and head and absolute plaster immobilization are essential. Laminectomy is inadvisable in sinus cases.

FIG. 383. — Plaster support for spinal caries, windowed in front to permit forward easement of chest. (Calot, Goldthwait.)

4. CORRECTION OF DEFORMITY. — (*a*) Gradual. — The GRADUAL correction of the kyphosis[3] may be made by head extension, supplemented by local pressure on the projection through a progressive series of jackets, or by pads applied during hyperextension, or by placing the patient on an arched frame (Fig. 366, p. 424).

Although Calot has abandoned his dangerous practice of immediate forcible straightening of the kyphos, he still endeavors to reduce the knuckle by degrees.[4] He suspends the patient by the neck and applies, on sheets of crinoline, plaster cream made with five parts of plaster to three of cold water. The sheets are closely molded behind, in front and about the neck. An ample window is cut in the cast in front (Fig. 383) and another behind over the knuckle. Through this posterior opening are tucked several thicknesses of absorbent cotton (Fig. 384) which are compressed against the kyphos by circular turns of a

[1] Willard, Jour. Nervous and Mental Dis., 1886, 223; Trans. New York Neurological Society, 1886; Trans. Phila. Coll. Phys., 1889, 74, and 1891, 39.

[2] Munro, Jour. Amer. Med. Assoc., Oct. 22, 1904; Thorndike, Amer. Jour. Orth. Surg., Oct., 1904, and Apr., 1906; Bradford, Bost. Med. and Surg. Jour., Sept. 20, 1900.

[3] Lovett, Amer. Med., Sept. 6, 1902; Taylor, Kyphotome, Johns Hopkins Hosp. Med. Bulletin, Feb., 1901; Gillette, St. Paul Med. Jour., July, 1901.

[4] Calot, Traitement rational du mal de Pott a l'usage des Practiciens, Paris, 1906.

plaster bandage. After hardening, these
body to permit expansion in that dire
cotton are applied every fifteen days w
jacket is made as required. By this
from two to five years, the patient ren
of treatment. After the redressment is
worn for three or four years. Massage,
the legs and arms should be freely use
bency, to which should be added, as
walking with trolley support, and out-dc

FIG. 384. — Plaster support for spinal caries, with opening over kyphos for insertion of cotton and application of pressure by secondary bandage. (Calot, Goldthwait.)

Gill applies pressure with a wooden p
cotton pad. This gives ready inspectio

(*b*) Forcible Immediate St
ity. — The revival of the old and dan
pocrates for the reduction of the ky
ous. Permanent cure of spinal caries
column sufficiently strong to support the
break up the bony deposits that tend to
and carious bodies, to widen this gap by
and expect new osseous deposits in an are
is to invite abscess, failure, or death. It
continued and persistent paralysis that

[1] Willard, Trans. Amer. Orth.

The method as practised by Chipault and Calot consisted in elevating and supporting the upper and lower portions of the trunk in the prone position, applying extreme force to the kyphos by the hands of the surgeon while forcible extension was made upon legs and arms. If too sudden and great force is exerted, injury to the dura and cord or bone will result.[1]

5. Wiring of the Spinous Processes.—Relief of the carious bodies by throwing the weight upon the posterior arches by wiring together the spinous processes[2] (Hadra, Lange), while theoretically helpful has not been sufficiently practised to determine its practical advantage.

Prognosis.—Unless diagnosed and treated early, a tuberculous spondylitis followed by caries and abscess will extend over a period of two to five years. At the present time, while the condition is a most serious one, the death rate has been markedly lowered by the adoption of the plan of keeping the patient out of doors throughout the entire period of treatment, even during the acute painful stage, securing rest of the diseased area by mechanical support, and if abscesses require opening, carefully guarding them from septic mixed infection. Environment, resistive power, heredity and pecuniary ability of the patient to secure proper care, food and surroundings all have a positive influence on the prognosis.

Spinal caries is the most dangerous of all the tuberculous joint diseases, since the focus exists in the trunk, is nearer to vital organs, is more difficult of treatment and less easily subjected to drainage and surgical removal. Few cases of extreme thoracic kyphosis reach old age. Prolonged suppurative cases frequently die from exhaustion, with amyloid changes in organs or from tuberculous meningitis or phthisis or acute miliary tuberculosis. The death ratio is uncertain since statistics are masked in mortality records which report death from many indirect results of the original lesion. Probably 25 per cent. die before middle life.

In adolescents and adults, spinal caries is a very serious condition, consolidation of the vertebræ being seldom effected even with good treatment. The duration is long and tedious and the final outlook unfavorable.

Suppuration will persist as long as any carious bone exists, and in cases where large destruction of vertebræ has taken place with mixed infection, this process may continue for years. Abscesses may rupture into blood-vessels or into the pleura.

Paraplegia, if treated by rest and fixation as soon as recognized, may be cured in a few months, but if the tuberculous deposit in the canal is large, from one to two or even three years will be required before the patient will be able to walk. As a rule, however, a large majority of these paralytics (80 to 90 per cent.) finally recover the use of their limbs.

In childhood if the disease is recognized early and the appropriate treatment applied, recovery with slight deformity is common. In undiagnosed cases, where extensive caries has already occurred, recovery by ankylosis and permanent fixation is possible, sometimes without the recognizable formation of pus; but when inflammation and mixed infection are added to the tuberculous process, suppuration is a sequel that occurs in about one case in five.

[1] Monod, Gaz. des Hôpitaux, 1897, 70, 756; Gaz. Méd. de Paris, 1897, 10, 23.

[2] Trans. Amer. Orth. Assoc., 1891, 209; Lange, Amer. Jour. Orth. Surg., 1910.

SUMMAR

1. Spinal caries is the result of a tu
bral bodies, frequently ending in bone de
formation, or paraplegia.

2. The earliest symptoms are all in
ticeable. Rigidity and reflex pains and
demand a careful examination of the r
spine will be found resistant to motion in

3. The deformity of a projecting spi
that bone destruction is already advance
sible.

4. Out-door life and healthful surrou
importance in increasing the resistive po
vasion. Recumbency on an arched bed-f
extension and fixation are important to r
rect deformity.

5. Mechanical support by jacket o
from two to five years. Above the seven
necessary.

6. Operative measures are indicate
abscess or paralysis.

7. Spinal caries paraplegia is curable
recumbency and fixation for from one to

CHAPTER XIV.

SPINE, VARIOUS SURGICAL CONDITIONS.

SPINA BIFIDA; HYDRORRHACHIS.

SPINA BIFIDA is a hernia of the contents of the spinal canal through a defective or absent portion of the vertebræ, either posterior, lateral or anterior. The contents may consist of cerebrospinal fluid covered by membranes only, or of additional cord elements. The protrusion may occur at any portion of the canal, from the skull to the sacrum.

This congenital defect of the laminæ of the vertebræ occurs about once in a thousand births. It is due to a developmental fault in the coalescence of the arches of the embryonal neural groove before the cord is segmented from the epiblastic layer. RHACHISCHISIS is a complete absence of union.[1] The faulty arching of the medullary plates to form the medullary grooves and their failure to unite, from internal pressure upon the cartilaginous vertebral arches in the early months of embryonic life, readily induce a protrusion of the contents. Trauma or amniotic adhesions may also act as a productive cause. The association of this defect with encephalocele would indicate that hydrocephalus plays an important part in producing the internal pressure (p. 27).

Other deformities of the body, as well as those of the lower limbs, would indicate a serious impairment of developmental control. Club-foot and paralysis of legs are most common when the cord constituents remain in the sac instead of making their way to the limbs, as in normal development. Cleft palate, hare-lip, hydrocephalus, imperforate anus and other deformities are also frequently associated.[2] In masked cases the region of the tumor is covered with a growth of hair. When only cerebrospinal fluid fills the tense sac the limbs may be apparently normal, but even in cases of OCCULTA the limbs may be deformed or useless. Mentality is often defective; when the tumor is pressed upon, convulsions are not uncommon and the fontanelles will simultaneously bulge.

A MENINGOCELE consists of a protrusion of only the meninges and contains arachnoid cerebrospinal fluid. A MYELOCELE contains more or less of the cord filaments spread out within the sac. In MENINGOMYELOCELE or HYDROMYELIA, the structures of the cord remain still united to the surface epiblast and the filaments stretch out across the sac, sometimes united to its wall.

In SYRINGOMYELOCELE, MYELOCYSTOCELE, all the elements of the cord are involved but there is also an ependyma or dilatation of the central canal.

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[1] Guthrie, Penna Med Jour., 1905

[2] Porter, Indiana Med Jour., Jan., 1908.

ANTERIOR SACRAL SPINA BIFIDA is
of the contents of the canal through
rarely diagnosed except during abdomin
have been reported when the discovery
case of both anterior and posterior defect
386, 387).

A spina bifida at birth is usually cov
membrane oozing serous fluid and threa
tumor may be sessile or more or less pedu
ulcerated surface heals and a thin skin
tumor varies greatly in size and increases

Diagnosis. — Meningomyelocele som
dimpling of the sac; the opening in the lar

FIG. 386.—Spina bifida, anterior and posterior defects in vertebræ.

FIG

paralysis of the lower limbs more frequer
be seen through the thin walls. Meningo
smaller pedicles and smaller bony openi
vealing the extent of the defect.

Fig. 388 shows the X-ray shadow of

A growth of HAIR OVER THE SACRU
bifida occulta that it is wise to be cautiou
this region. In the same region also may
white race, the "blue spots" or pigmen
Mongolian races and in negroes. Lipo
bifida, especially the occulta variety, but
and more movable. Teratomata also ma

[1] Willard, Annals of Surg., April, 1904, xxxix,

region. Dermoids and cystic hygroma must be carefully differentiated, as well as sciatic hernia.[1]

SPINA BIFIDA OCCULTA consists of a hernia so small and firm that its presence is often unrecognizable, save for skin or hair alterations over its surface.

FIG. 388.—Skiagram of anterior and posterior spina bifida (see Figs. 386 and 387).

In spina bifida occulta, the cord and membranes may be intact, or the latter may emerge through a very small defective opening.

The author has reported a spina bifida occulta[2] in which the bony defect existed, but, the protrusion being slight, it had been undiagnosed for years, although there was marked distortion of feet which had been several

[1] Wilson, Amer. Jour. Obstet., vol. xlii, 4, 1900.

[2] Willard, Annals of Surgery, xxxvii, 457; Trans. Phila. Acad. Surg., v, 150.

times operated upon. In another case
found on operation to be lateral, the tu
gluteal region[1] (Fig. 389).

In a case recently seen by the author,
ate lumbosacral injury showed the condit
visible tumor. The question of fracture
came under consideration, but it was fi
defect existed and that the patient had
occulta. Sever reports a similar defect i

Treatment.—The tumor should be p
found unsuitable for operation and in cas
leather or celluloid or aluminum shield m
plaster or bandage. Ulcerated surfaces

FIG. 389.—Spina bifida with low lateral opening.

have been reported from injections into
and does not offer great hope of relief.
of iodide of potassium 30 grains; iodine 1
the withdrawal of one-half of the fluid c
drachms are injected through a puncture
tumor. The mortality is about 50 per ce

Brainard advocated the withdrawal of
injection of a half ounce of a solution of
grains potassium iodide to the ounce o
ounces of the original spinal fluid.[3]

Sterile cerebrospinal fluid obtained b
line and has a specific gravity of 1000–
than a trace of albumin and although the

[1] Willard, Ann. Surg., Sept., 1902, 452; Tr. P
Mag., i, 470; Therap. Gaz., April, 1895; article b
vii, 653.

[2] Boston Med. and Surg. Jour., Sept. 16, 1909,

[3] Amer. Jour. Med. Sci., 1861, 65.

with Fehling's solution, yet subjected to further tests, the reducing substance is shown not to be sugar.

Resection.—Plastic excision of the sac offers a reasonable hope of relief, particularly in cases which contain only cerebrospinal fluid. When cord elements are in the sac they cannot of course be transplanted to their proper termination in the legs.

The time of operation by choice is as soon as the infant is fairly started in life, at the end of two months, especially if the covering threatens to burst. If the sac bursts during labor, an aseptic dressing should be applied at once and the operation of closure performed the same day, otherwise an immediate fatal result may be expected. The opening may be closed by a ligature and covered with compound tincture of benzoin and cotton, but death will usually result. In cases with small spinal opening and thin translucent covering threatening rupture, with a child in generally healthy condition, the operation can be performed on the second or third day. A thick-skinned tumor can be left to await developments. If the child's condition is poor, the operation may be delayed for a few months.

Fig. 300.—Congenitally defective lamina simulating fracture of vertebral arch.

The utmost care must be employed to avoid shock and hemorrhage, as young infants are very non-resistive. The entire body should be covered with cotton and an electric heated operating pad employed to avoid loss of body heat. Ether is the safest anesthetic. The skin disinfected by tincture of iodine should be dissected carefully from the sac and useless portions of it removed. If the neck of the sac is compressed by fingers, the escape of cerebrospinal fluid can be controlled and the interior of the sac examined for cord contents. If the cord elements are attached to the wall, they may be retained, although they will be but of little service. If no cord contents are found, the sac should be tightly closed by iodinized or chromicized catgut ligature. Escape of fluid may be lessened by operating with the infant upon its face, with buttocks higher than the head. Redundant portions of the sac are excised, leaving sufficient flaps to be tightly sutured over the ligature. Cord filaments may be returned to the canal, although it is doubtful if this procedure is of any considerable importance. The cases of paralysis benefited by operation have probably been instances of pressure paralysis only. Large flaps of

skin, fat and fascia are then slid inward from the loin, either by making longitudinal incisions and dissections or by inversion, until the opening can be well supported by these flaps stitched carefully in place. If osteoplastic flaps are used they should be firmly sutured in the opening. The raw surfaces left on either side will close by granulation. Over these flaps the skin is closed with silkworm sutures. Compound tincture of benzoin and collodion and a firm aseptic dressing are applied, supported by a light gypsum bandage which can be shellaced or covered with rubber tissue. The utmost care will be necessary in packing about the anus and urethra with abundant gauze and absorbent cotton, and the child must be kept upon its abdomen in the nurse's lap. A penis can be carried through an opening in rubber tissue and with close watching and plenty of cotton, soiling may be prevented, but dressings must be frequently changed. Even with rapid operation, the shock is severe.[1]

FIG. 391.—Osteoplastic closure of a spina bifida in an infant by lateral bone flaps. When seen two years later, the union was firm and the tumor had not returned, but hydrocephalus had developed.

OSTEOPLASTIC FLAPS[2] can be easily cut from the posterior ilium or sacrum or lumbar vertebræ (Fig. 391). These are reversed upon their bases and turned in over the sutured sac, beneath the fascial and muscular plastic flaps, to strengthen the closure but the operation must be speedy. With strict aseptic precautions before, during, and after the operation, sepsis which is one of the greatest causes of death may be prevented. Drainage should be avoided.

Prognosis.—Fortunately the majority of these cases die early, especially the myeloceles, death occurring from rupture of sac, meningitis, malnutrition or paralysis.[3]

Of 649 children that died of spina bifida in England, 612 succumbed in the first year. Ninety (unoperated) died within the first week.[4] Only 20 lived more than 5 years. The mortality from iodine injection was 38 per cent.

The mortality of the operation itself will be from 25 to 30 per cent. and the majority of cases will die later from meningitis or post-operative hydrocephalus with mental impairment. Meningocele cases are of course more hopeful than myeloceles. The paralysis which is due to absence of nerve supply, cannot of course be benefited by operation, and in some cases paralysis developing after the operation is severe and persistent. Bladder paralysis often causes kidney infection. With thoroughly aseptic technic a few cases can be saved.

Hydrocephalic and paralytic cases and those with very large sessile tumors should not be operated, nor should small tumors that are well covered with skin.

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[1] Lovett, Amer. Jour. Orth. Surg., Oct., 1907, 208.

[2] Willard, Ann. Surg., 1902, xxxvi, 452; Trans. Phil. Acad. Surg., 1902, 94; Univ. Med. Mag., Phil., i, 470.

[3] Khirurgia, Mosk., 1909, xv, 8 and xxv, 28.

[4] Report, Clin. Soc. of London.

TERATOMA AND LIPOMA.

Congenital masses the result of defective development may cover a spina bifida occulta and contain tissues derived from the germ layers.

DERMOID and EPIDERMOID cysts also occur in the sacrococcygeal region. The complexity of the contents of teratomata has caused much confusion as to their derivation. Many investigators consider that they are bi-germinal and are the remains of a parasitic or second ovum. The mono-germinal tumors contain elements from the three layers of the neurenteric canal, ectodermal, entodermal and mesodermal.

Removal is only necessary when the tumor is enlarging or giving discomfort. These tumors are usually solid, and caution should be observed if operation is undertaken, lest the cord be opened. The lipomata have no capsules.

SPONDYLITIS, TYPHOID AND INFECTIOUS.

Since Gibney called attention to the TYPHOID SPINE in 1889, many cases have been noted.[1] In the majority, the Widal reaction and the clinical symptoms have demonstrated the existence of typhoid fever. Frequently however some other infection has been present, the septic symptoms having been mistaken for typhoid (Acute Infectious Arthritis, p. 580).

This form of spondylitis may be an ostitis, a destructive osteomyelitis, a chondritis or a periostitis. It usually occurs during convalescence and is rare in children under fifteen years of age. Sprain and trauma may be the exciting cause. The pain is often excruciating, especially in the lumbar region, and may be due to the strain upon the lumbosacral ligaments, due to sitting up too early while the muscular support is feeble, a condition described on p. 451. Local tenderness and rigidity exist, and later kyphosis may occur in one-third of the cases.

Prognosis is usually favorable.

Treatment.—Rest, protection, extension, immobile support and the high-frequency current are essential in relieving pain; either a spinal brace or a plaster jacket may be worn, the latter being applied with the patient lying face downward on a hammock (Fig. 367, p. 425). A rigid support should be worn for months.

SPONDYLOLISTHESIS.

This rare condition consists in a forward subluxation of the last lumbar vertebra from the sacrum. Marked lordosis, tilting of pelvis, shortening of trunk, altered gait, etc., should lead to a thorough examination of the naked body.[2] A radiogram will assist in diagnosis from congenital dislocation of the hips, rickets, spinal caries and tabetic arthropathy of the lower vertebræ.

A firm corset or steel support will give comfort[3] (Fig. 376, p. 430).

[1] Trans. Amer. Orth. Assoc., 1889; Amer. Jour. Orth. Surg., Oct., 1907, 180.
[2] Trans. Amer. Orth. Assoc., 1897, 20.
[3] Amer. Jour. Orth. Surg., Jan., 1908, 324.

SPINAL BLASTOMYCOSIS.

An elastic tumor appearing over the spinous processes, with pain and stiffness and loss of weight, will render diagnosis difficult.[1] Tuberculous disease, abscess, and sarcoma must be differentiated. Aspiration of dark-colored pus should lead to laboratory examination, and if budding blastomycetes are discovered the sac should be thoroughly opened, diseased hard and soft tissues removed and the region mopped with 2 per cent. formalin solution or carbolic acid or copper sulphate or iodine. Sodium iodide may be given internally.

Actinomycosis of the spine is rare.

SPONDYLITIS DEFORMANS.

Synonyms: Osteo-arthritis; arthritis deformans; rigid spine; spondylosis rhizomelic (Marie, Bechterew, Strümpell).

A chronic inflammatory process of the articulations of the spine with secondary involvement of the cord is occasionally encountered. In the cord, vascular changes are evident; in the bone, ultimate complete ankylosis results.

This slowly progressive rigidity of spine is often erroneously treated for rheumatism or lumbago. It so rarely occurs in childhood that its general consideration under Arthritis Deformans (p. 585) is sufficient.

Warm clothing, good food, open air, electricity, massage and hot air, with iron, arsenic and strychnine will be helpful. A spinal support or plaster or leather jacket will give fixation and protection (Fig. 219, p. 279).

SUPERNUMERARY AND ABSENT VERTEBRÆ.

The existence of a supernumerary or an absent segment of the spine is seldom diagnosed except by the X-ray and is usually noticeable only by some concurrent deformity. Such a malformation is occasionally the cause of lateral curvature (p. 251) or torticollis (p. 68) or high shoulder (p. 558).

SPINAL CURVES.

KYPHOSIS.—A posterior bending of the spine may be angular as in spinal caries, or curved as in rickets, paralysis or osteo-arthritis. The normal backward curve in the thoracic region is not a kyphosis, but it may be exaggerated in round shoulders and in spondylitis deformans.

LORDOSIS.—A natural anterior curve in the lumbar region is normal in children after walking has commenced. This curve is exaggerated into a LORDOSIS (Fig. 604, p. 725) in congenital malformations of the hips, in hip-joint disease, rickets, ankylosis of the hip, spondylolisthesis, spinal caries with psoas abscess, contractions at the hip and in paralyses.

SCOLIOSIS.—Lateral curvature of the spine is due to various causes, as discussed fully under Rotary Lateral Curvature (p. 251). A LATERAL TILT at a definite point is usually due to a caries which has destroyed the body of a vertebra upon one side more than the other (p. 418).

[1] Brewer, Ann. Surg., 1908, xlviii, 889.

SPINAL TRAUMA.

Injuries of the spine are common and are so free from visible or palpable evidences that they are often misjudged.

As the spinal column is made up of a number of segments, any forcible bending of its regions may be temporarily unnoticed, especially in the shock and excitement of a railroad or other accident. The ligaments or muscles may be torn or contused, periosteum stripped from the bone, nerves stretched, torn, contused or crushed. Sprain or strain of ligaments and muscles, especially in the lumbar region where mobility is slight, is common. Hemorrhage and infiltration around the exit of the spinal nerves may result in a perineuritis ending in muscle atrophy (p. 453).

SPRAIN, with or without laceration of muscles and ligaments, or STRAIN will be followed by symptoms varying with the injury and the region of spine involved. Sprain of the sacro-iliac joints is not uncommon in railroad injuries.

Symptoms.—PAIN.—The pain may be masked by the severity of the accident and not appear until some hours later; or it may develop by pressure upon the emergent nerves following hemorrhage and hyperemia. The pain may increase for days or weeks, being sometimes extreme and resisting all measures of relief. It may extend from the spine down the legs, if the dorsal or lumbar region is involved, or it may be shooting in character radiating to the rectum (p. 452).

NERVE SYMPTOMS.—The resultant perineuritis will give alterations in both sensation and motion and loss of power in certain groups of muscles, with subsequent atrophy. TRAUMATIC NEUROSES, simulating hysteria, are but seldom encountered in young children, but in neurotic adolescents, especially when injudicious pampering has been long continued, a complicated series of symptoms will give great difficulty in diagnosis.[1] Spinal concussion and traumatic neuroses or hysterical spines are so largely discussed in both neurologic and surgical treatises, that space need not here be given to diagnosis[2] (p. 657).

CONTUSIONS and CONCUSSIONS or LACERATIONS from FORCIBLE BENDINGS of the COLUMN may be followed by hemorrhage into the canal, producing paralysis coming on possibly several days after the accident. The author has seen numerous cases of this result due to striking the head while diving in too shallow water. Local pain and gradual but increasing loss of power appear, the hematorrhachis developing one or two days after the injury. Spinal puncture will disclose blood which may be extradural or beneath the meninges or within the cord. The absence of fracture or dislocation is to be inferred from the late appearance of the symptoms. Fractures and dislocations of the spine in children require practically the same treament as in adults and need not here be discussed.

In a recent case under care of the author, a child of three years fell thirty feet, striking upon his head in a pile of coal and inflicting severe scalp and face wounds. No brain or spinal symptoms were evident at first, but in

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[1] Jour. Amer. Med. Assoc., May 23, 1908, 1679.

[2] See article by the author in Bryant and Buck's Amer. System of Surgery, vol. ii, p. 518.

a few days there were severe pains and spinal rigidity. When seen three weeks later an acute spondylitis was evidenced by pain, local tenderness, rigidity and slight kyphosis, high temperature and pulse. Fixation of the spine and total rest in bed for three months, followed by the use of a leather jacket, arrested the inflammation, and as tuberculous heredity was absent, caries was prevented and a perfect result secured. Numerous similar cases of injury from falls or contusions have been treated by rest and prolonged mechanical protection, thus escaping permanent disability. The use of a wheeled litter (Fig. 364, p. 423) or flat platform on wheels permits an out-door life with complete rest (Spinal Caries, p. 424).

CHAPTER XV.

SACRO-ILIAC AND SACRO-LUMBAR SPRAIN.

SPRAIN (tearing) and strain (stretching) of the sacro-iliac and lumbo-sacral ligaments may occur from distinct trauma or from excessive forcible hyperextension, or from hyperflexion of this region when the muscles are relaxed from disease or during the administration of ether. Relaxation of the pelvic ligaments as well as muscles is also common in adolescents during menstruation and especially later in pregnancy. This relaxation sometimes amounts to total disability if pubic ligaments are also involved.[1] The relaxation of the pelvic joints and increased mobility during the menstrual period in young girls is sufficient to account for the backache and weakness so often present. Backache is dependent upon a variety of causes other than the one to which its origin is usually ascribed, *i.e.*, pelvic disease, although it is naturally most common after uterine or rectal disturbances. Many cases have been operated on by gynecologists where no pelvic disease existed. Strain in lifting or stooping is common and may amount to absolute sprain or tearing of ligaments, with pain, "stitch in the back," lumbago, or sciatica, due to irritation of the sacral nerves which inside the pelvis pass directly over the sacro-iliac joint. Frequently periosteal attachments of the erector spinæ group of muscles are torn up. These cases are too often classed as neurasthenic spines or traumatic neuroses when the element of hysteria is entirely absent. Flat-foot, short leg, lateral curvature, temporary spondylitis, as well as commencing spinal caries and osteo-arthritis, are frequent causes of backache and require careful and repeated examinations. Fixation in a plaster jacket is as necessary in a sprain of the spine or of the pelvis, as it is in sprain of the ankle.

The sacro-iliac joint is not strictly a synchondrosis. It is endowed with a certain amount of motion and is very liable to sprains and strains of the posterior and of the oblique sacro-iliac fibres. The sacrolumbar ligaments above are also subject to sprain, especially during muscular weakness or debility.

A condition that is of great practical importance to every operating surgeon is the pain in the back complained of almost universally by patients who have recently undergone operation. This pain is partially due to the hard glass operating table upon which the patient often lies for an hour or more. It will be a revelation to the surgeon if he will lie there for five minutes. An additional and practical explanation is to the effect that during the muscular relaxation of anesthesia[2] the naturally slightly lordosed condition of the spine disappears and the pelvis is tilted to an unnatural

[1] Goldthwait, Painter, and Osgood, Dis. of Bones and Joints, also Best Med. and Surg. Jour., May 25, and June 1, 1905, Trans. Phila. Coll. of Physicians, 1908, Jour. Amer. Med. Assoc., Jan. 819.

[2] Jour. Amer. Med. Assoc., 1907, 849.

position, thus throwing the weight of the body, plus manipulations, upon the ligaments of the pelvis, producing sprain or strain at both sacro-iliac and sacro-lumbar articulations. Through the long lever of the femur in the forcible movements required for breaking up a firm ankylosis of the hip severe injury will result. The pain following such a sprain will naturally be severe and will be aggravated by lying in bed upon the back, in which position the ligaments continue to be stretched. The prevention of this accident lies in placing a lumbar pad beneath the sterile operating sheet and the use of a similar lumbar spine support after operation. Great relief will result from turning the patient upon the side.

Symptoms.—PAIN.—The backache which is so common may be localized over one or more of the articulations but is usually complained of as sacral. The pain may be referred down the thigh, since the sciatic cord passes over the upper part of the sacro-iliac joint. The movements of the region will be guarded and stiff, the pain on rising or bending often severe. There will be no rigidity of the hip when lying. If ligaments are relaxed, the strain of lying flat on the back increases the pain.

MOBILITY.—Increased mobility will be noticed by flexing the thigh on the abdomen, with knee held straight. If the relaxation is great, there may be a subluxation backward of the upper part of the sacrum. The feeling of helplessness and disability is most common after pregnancies. Areas of anesthesia of skin and other sensory manifestations soon follow. Knee-jerks and ankle clonus will not be observed unless the cord is involved. In lumbosacral cases movement of the injured spine will be rigidly avoided. Rising, stooping, jarring, and straining at stool will give stabbing pains in back, pelvis or rectum. The spinal muscles are often in a state of rigid spasm. Neurotic symptoms are likely to follow as in any case of prolonged pain and disability. The pain may be upon one or both sides and tenderness can be elicited by movements or twistings of the body. In acute and violent cases the tenderness may be local over either articulation, but the excruciating pain will extend throughout the entire region or into the groin, or down the legs from irritation of the accessory obturator, or into the rectum. Succussion from the diaphragm in coughing is agonizing. In chronic cases the backache and pain in the spine and headache are often taken as evidences of pelvic disease, especially as the pain is usually exaggerated in girls at the menstrual periods from relaxation of the ligaments. The pain is sometimes worse on rising in the morning, as motion throws a strain upon the ligaments if a pillow has not been used in the lumbar region. In acute cases the patient will guard the movements of the region as persistently as will a case of spinal caries, all stooping or bending being exceedingly painful. If the sprain is unilateral, the body will be bent toward the side, from spasm of the lumbar muscles to relieve pressure. Increased motion can sometimes be felt on one side, if one hand is placed over the sacrum, the other over the symphysis pubis. Voluntary flexion of the thigh, both standing and lying, will be limited and painful, and rocking from side to side or lateral bending will increase the pain.

If the periosteum near the joint is torn up, the subsequent inflammatory changes with resultant pressure upon the nerve-trunks at their

exit or in their course, may result in neuritis, phlebitis, thrombosis, impaired nutrition resulting in muscle atrophy and diminished powers of locomotion with localized alterations in sensation. Especially will these results follow in lumbosacral injuries if a pneumococcic infection is also present.

The author recently had the opportunity to observe a serious result from lack of the normal muscular support of the pelvis and spine. A patient, after five months of confinement in bed from an extremely exhausting infectious pneumonia with empyema, was placed in a rolling chair. In simply bending forward, the lumbar and lumbosacral ligaments were stretched or torn and in one hour the pain was so excruciating as to be almost unbearable. For four weeks the slightest movement of the bed or body, or a cough, would so intensify the agony as to throw the legs into con-

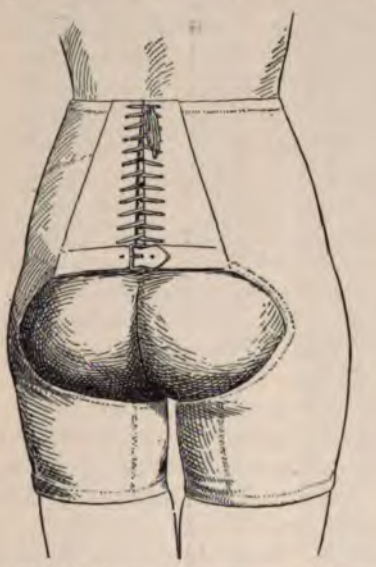

FIG. 392.—Laced support for sacro-iliac relaxation. (Goldthwait.)

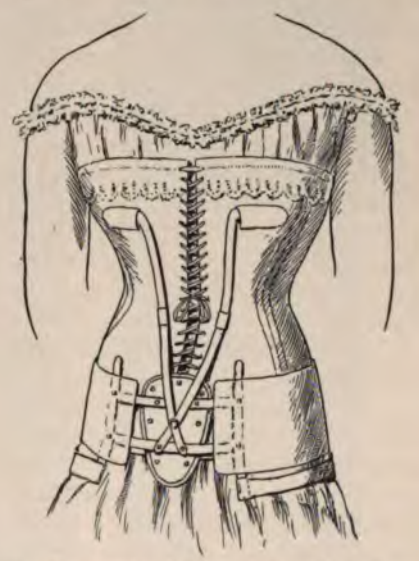

FIG. 393.—Sacral pad with uprights and pelvic corset for sacro-iliac sprain. (Goldthwait.)

vulsive movements. For months the act of defecation aroused lightning-like stabs of pain that extended from the rectum to the lumbar region. Local strapping and internal anodyne remedial measures failed to benefit the pains until at the end of a month three applications of the high-frequency current relieved the pain so greatly that the patient was able to be moved with the support of a closely laced spinal corset, which firmly fixed the pelvis and, by steel bars, prevented flexion of the spine (Fig. 394). This was worn for six months, the pain in the back slowly decreasing but intensified by motion or jar. A fibro-ostitis or perineuritis or periostitis developed in a few days around the spinal nerves at their exit from the vertebræ, which ended in a neuritis in one leg with permanent atrophy of several muscles and tingling, numbness and alterations in sensation in other areas, with uncertainty of muscular control. Thirty per cent. of loss of power was still persistent at the end of a year. In the other leg, the external iliac vein became obstructed and an extensive phlebitis developed,

with swelling of leg, penis, scrotum anc
permanent induration of limb.

In chronic sacro-iliac cases, stretchi
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Hip disease may be simulated, as
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help in diagnosis.

FIG. 394.—Author's support for sacrolumbar and sacro-iliac sprain. The posterior steel uprights extend as low as permissible for the sitting posture.

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SUBLUXATION OF THE SACRUM or sp
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SACRO-ILIAC DISEASE; TUBERCUI

TUBERCULOUS disease of the sacro-ili
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the same as in other tuberculous processes (

Symptoms.—The erect posture as well
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[1] Dunlop, Amer. Jour. Orth. Sur

location and is indicated rather by the limp than by local distress. The child will object to movements of both hip and lower spine, and rigidity in both areas is occasionally present. Pain and tenderness are at first slight but advance steadily. Pressure upon the crests of the ilia or hips gives pain at the articulation. Pain is usually relieved by the recumbent position, although sometimes worse at night even when the patient lies on the sound side. Limping is constant when weight is brought upon the limb and the patient early seeks the aid of crutches and avoids all trauma. The bladder and rectum may become irritable. Instability of the pelvis is notable. Bendings of the body are avoided but differ from the rigidity of

FIG. 395.—Sacro-iliac tuberculosis with sinus openings in front and rear.

spinal caries. Pain down the sciatic is not uncommon, as the lumbosacral cord passes over the upper posterior part of the articulation, and there is pain if pus makes its way out of the sacrosciatic foramen. The carious process sometimes involves both lumbar vertebræ, ilium, sacrum and hip. The resultant pus may make its way backward over the joint; downward into the thigh or into the buttock or ischiorectal fossa or rectum; upward to the lumbar region; forward into the iliac fossa, simulating psoas abscess (Fig. 395).

Diagnosis.—The joint lies so deeply that diagnosis from hip and spine disease, iliac caries, lumbago, iliac sprains, perinephritic abscess, appendiceal and pelvic abscess and ovaritis, is often difficult. These conditions are discussed in other portions of this volume.

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Abscess or sarcoma of the kidney, ps
or disease of the colon may also be simulat
to the diagnosis of the condition.

Osteo-arthritic bony deposits about t
or both sides and give much pain during
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somewhat similar symptoms, often of seve

Treatment.—Rest in bed is helpful.
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FIG. 396.—Sacro-iliac tuberculous disease with sinus openi
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TREATMENT and all the measures discusse
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If abscess forms, incision should be made
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with carbolic acid and alcohol or iodine, a
pus is within the abdomen, a trephine or
ilium to permit free drainage (Fig. 396).

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CHAPTER XVI.

HIP-JOINT DISEASE, TUBERCULOUS.

Synonyms: Hip disease; coxalgia; tuberculous osteo-arthritis; morbus coxarius or coxæ; tuberculous caries of the hip; chronic tuberculous coxitis; tuberculous osteomyelitis.

COXALGIA means simply hip pain and designates only a symptom. The term HIP-JOINT DISEASE is now so thoroughly recognized by surgeons as especially descriptive of the tuberculous process that the infection is usually denominated simply—HIP DISEASE.

The condition is practically an infective tuberculous ostitis of the epiphysis of the head of the femur, or of the acetabulum, or both. The synovial membrane is rarely the primary lesion, but by progression all the tissues in the neighborhood of the joint become involved.

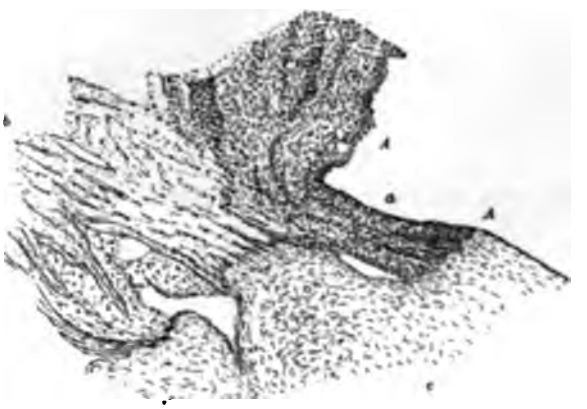

FIG. 307.—A, attachment of the synovial membrane to the cartilage of the head of the femur; a, synovial membrane, b, connective tissue, c, cartilage.

Etiology.—The causes of joint tuberculosis have already been described on p. 371. Heredity, environment, illness, trauma, syphilis, all have their places in its production.[1] The fight so long waged as to whether trauma or whether scrofula was the chief cause arose largely from a misunderstanding at that time as to the possibility of tuberculosis being only a local condition. It was not recognized that a tuberculous, strumous or scrofulous diathesis might be the PREDISPOSING cause, while trauma acted simply as the EXCITING agent, permitting infection. It would be very difficult to find any child in whom a history of repeated falls could not be traced.[2] Although still

[1] Willard, Jour. Amer. Med. Assoc., April 13, 1901, 1015.
[2] Willard, International Med. Mag., March, 1900.

unprepared to accept Gross' dictum[1] that tuberculous and syphilitic hereditary influences are closely related, yet the latter disease undoubtedly has large influence in hereditary bone and joint lesions.[2]

FIG. 398.—Attachment of the ligamentum teres to the head of the femur; *a*, synovial membrane with infiltration; *b* and *d*, connective and cartilaginous tissue; *c*, osseous surface.

Age.—Tuberculous hip disease is essentially a condition of early childhood, 85 per cent. of the cases originating before the tenth year, but adolescents and adults are liable to the infection.

Sex.—As the activities of boys and girls are nearly equal, the influence of sex is not prominent as a factor under the age of ten.

Frequency. — In frequency, hip disease stands next to spinal caries in the list of joint tuberculoses.

Pathology. — The pathology of hip disease is the same as that of other tuberculous joint diseases elsewhere discussed (p. 368). For microscopical evidences in bone and joint tuberculosis see *Frontispiece*. The infection usually takes place in the epiphysis of the head of the femur, rarely in the acetabulum or synovial membrane or in the trochanter or neck.

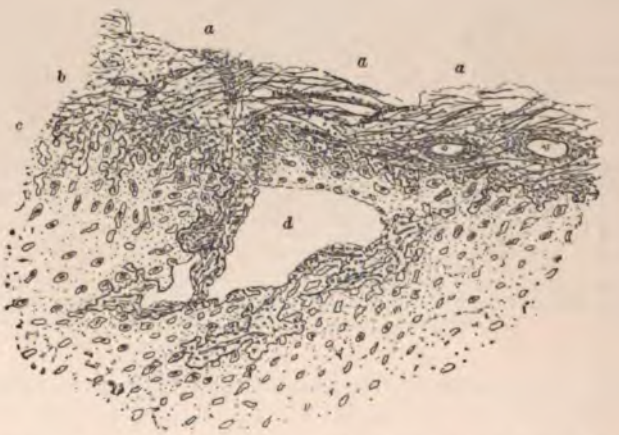

FIG. 399.—Attachment of ligamentum teres to the acetabulum, with cartilage softening: *a*, ligament; *b*, line of attachment; *c*, cartilage undergoing softening; *e*, soft area filled with granulation tissue; *d*, space from which tissue has fallen out.

That slight hip-joint traumatisms tend to tuberculosis, especially in a child hereditarily non-resistant, is shown by Figs. 397, 398, 399, indicating the condition found in a patient of the author's that died of typical

[1] Trans. Amer. Med. Assoc., 1874.

[2] Syphilitic Lesions of the Osseous System in Infants, Taylor; Gibney, Diseases of the Hip, Octavo, 1883, 208.

tuberculous meningitis.[1] The microscopical appearances were chiefly those of a secondarily aroused inflammation, a few caseating cells in the ligamentum teres being the only points that could be taken for tubercles. Gross made numerous dissections and as far back as 1858 pointed out the fact that hip-joint disease (Figs. 400, 401) was often followed by other tuberculous manifestations.[2]

FIG. 400.—Scattered foci of disease in head of femur.

FIG. 401.—Carious foci.

Course.—The normal course of the disease is one of slow but gradual extension of tuberculous infection from the epiphysis of the bone toward the joint, destroying synovial membrane, cartilage, capsule, round ligament and acetabulum (Fig. 402). The latter may in time be perforated or destroyed, permitting the head of the bone to slide upward on the dorsum of the ilium—a pathological dislocation—or the socket itself may migrate upward from absorption of the rim. The head and neck slowly disap-

[1] Willard, Bost. Med. and Surg. Jour., Jan.,1881, cili, 437; Trans. Amer. Med. Assoc., 1880, xxxi, 925; Agnew's Surgery, vol. ii, 2nd Edition.

[2] N. Amer. Med. and Chir. Review, 1858.

FIG. 402.—Carious destruction of acetabulum, head of femur, cartilage and round ligament.

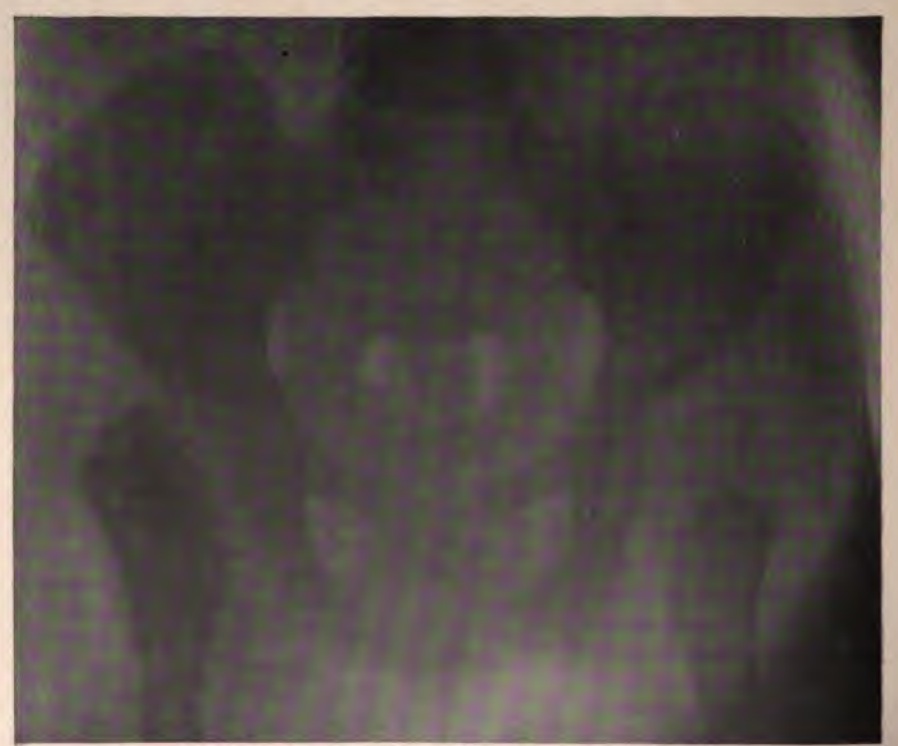

FIG. 403.—Tuberculous loss of tissue of head of femur without suppuration.

pear without visible signs of suppuration (Fig. 403) if mixed infection is prevented by proper treatment. Recovery takes place with ankylosis in a more or less deformed position, usually one of flexion, adduction and shortening (Fig. 404). If mixed infection occurs, long-continued suppuration is the rule with large loss of bone tissue. Tuberculous foci often remain quiescent for a long time, relapses being aroused by traumatism, forcible interference, or osteotomy.

Symptoms.—The onset is usually slow and insidious, in marked contrast to rheumatism or other acute disease. When the symptoms arise

FIG. 404.—Tuberculous hip-joint disease on left side with marked adduction. Similar infection of right knee.

FIG. 405.—Left hip-joint disease with slight flexion, abduction and external rotation.

suddenly, a positive injury can usually be located. Exacerbations and relapses are frequent from injury or disease or infection by pyogenic germs.

LIMP in the majority of cases will be the first symptom noted. This limp will be intermittent, chiefly noticeable on rising in the morning, disappearing for a time, but recurring in the latter portion of the day after exercise. This limp is the recognition by the brain of the necessity for shortening the time of impact of joint surfaces and is present before any local pain is distinguishable. Another factor in the production of limp is the flexed position of the limb. Locomotion is uneven, guarded and restricted.

POSITION.—When stripped, the child is noticed to stand with the weight

of the body thrown on one leg, the other flexed, abducted and rotated outward (Fig. 405). The pelvis will be tilted slightly upward, the internatal crease and vulvar fissure inclined to one side from the median line. The gluteofemoral crease will be lower and shorter; the buttock narrower and flatter; but this latter group of symptoms are only indicative of the position of "standing at ease" and are not diagnostic (Fig. 406).

MUSCULAR RIGIDITY AND LIMITATION OF MOTION.—A young infant may be examined on the mother's lap or lying across her shoulder. All older children and nearly all adolescents should be as nearly naked as possible and placed with their backs upon a hard table. The well leg should first be manipulated in all directions to gain the confidence of the patient and to form the basis of comparison. By this preliminary step, fear and voluntary muscular resistance will be lessened.

FIG. 406. — Disease of right hip-joint. Internatal crease inclined toward left thigh. Right buttock narrower, gluteofemoral crease shortened and less distinct—buttock fading away into thigh.

Among the earliest, most diagnostic and most constant symptoms of hip disease is REFLEX MUSCULAR SPASM. Its presence combined with limp and slight uneasiness at night along the inner side of the thigh, is sufficient for diagnosis. Coincidently with the limp and often before the appearance of pain there will be this muscular effort to prevent motion and friction of the tender and inflamed joint areas. Positive muscular resistance will be rigidly on guard to prevent motion in one or more directions. At an early stage the movement chiefly opposed will be backward extension. Later, if the femur is grasped by the surgeon and moved in any direction while the other hand holds the anterior superior spine of the ilium, the pelvis will be found TO FOLLOW AFTER the femur in all directions. These movements should be made in an acute case with exceeding caution and gentleness, violent rotations or abductions being never permissible, nor strong percussion on heel or knee. The amount of flexion is best tested while the patient is on the table on his back by flexing the thigh, thus bringing the pelvis into its normal line with the body and eliminating the lordosis (Fig.

FIG. 407.—Diseased hip flexed until lordosis of spine is obliterated, giving angle of flexion at 135°.

407). The angle of flexion is then easily determined and even in the early stage will often be found at 135 degrees, counting 180 degrees as the straight line. The amount of adduction or of abduction can also be readily determined by flexing the nondiseased thigh upon the abdomen. Upon releasing the hold upon the flexed well thigh and extending the diseased one to the level of the table, the lumbar spine will arch upward—lordosis—so

FIG. 408.—When knee is brought down to table, the lumbar spine is arched, showing fixed flexion of thigh and consequent lifting of pelvis.

that the hand will easily pass beneath (Fig. 408), the degree depending upon the amount of periarticular muscular resistance. This condition is not an ANKYLOSIS but is due to MUSCULAR RIGIDITY. An anesthetic is unsafe at this stage, since, if muscular protection is abolished, serious inflammation may be started by rough manipulation. Only at a much later stage should ether be employed to determine the amount of real fixation or fibrous or bony ankylosis. While the muscular spasm is an effort to keep the joint at rest, the effect is also to drive the head of the bone more firmly into the acetabulum, causing its absorption and giving rise to excruciating pain, especially at night. Gentle traction by the hand of the surgeon IN THE LINE OF THE DEFORMITY will sometimes put to sleep a child that has been screaming for hours with thigh instinctively grasped in its own hands to prevent motion. Rotation should be tested in both the flexed and straight positions. If extension, rotation, abduction and adduction are all resisted in one hip and not in the other, there need be but little question as to the diagnosis (Fig. 409). Another test for muscular flexion rigidity is made by placing the child face downward, and lifting the thighs. The well knee can be lifted 20 or more degrees from the table, while on the diseased side backward extension is resisted.

FIG. 409.—Flexion of the well thigh at once shows the actual amount of abduction and of flexion of the diseased hip.

PAIN.—Accompanying the limp and muscular rigidity or at a later period, recognizable pain will be felt, not locally at the hip at first but reflected down the inner side of the thigh and as low as the inner condyle of the femur and knee. This reflex pain is explained by the distribution of

the anterior crural filaments of the obt
passing in front of the hip capsule and te
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Fig. 410. — With joint effusion the limb is abducted and rotated outward from tension within the joint.

Night Cries. the peculiar night tom. These nigh the muscular syst ment of the inflar by the brain and sudden driving acetabulum. The cry and falls agai control; but the s intervals.

Atrophy. — muscles of the th earlier than would As the disease ad cumference of thig limb becomes ma ished growth also with the upper ep ment of the entire

Deformity. — slightly flexed, ab ducted. As joint the position of gr assumed[1] and the to tilting of the pe formation and ca position is assume to creeping or de ulum,—actual pat of bone tissue of pelvis and lessene In old cases with ankylosis in the adduct suppuration this shortening may amount

The apparent lengthening is indi umbilicus to the internal malleolus, the by the distance from the anterior superior Apparent lengthening is due to the abduc deavor to relieve the distended joint.

[1] Sherman, Trans. Amer. Orth

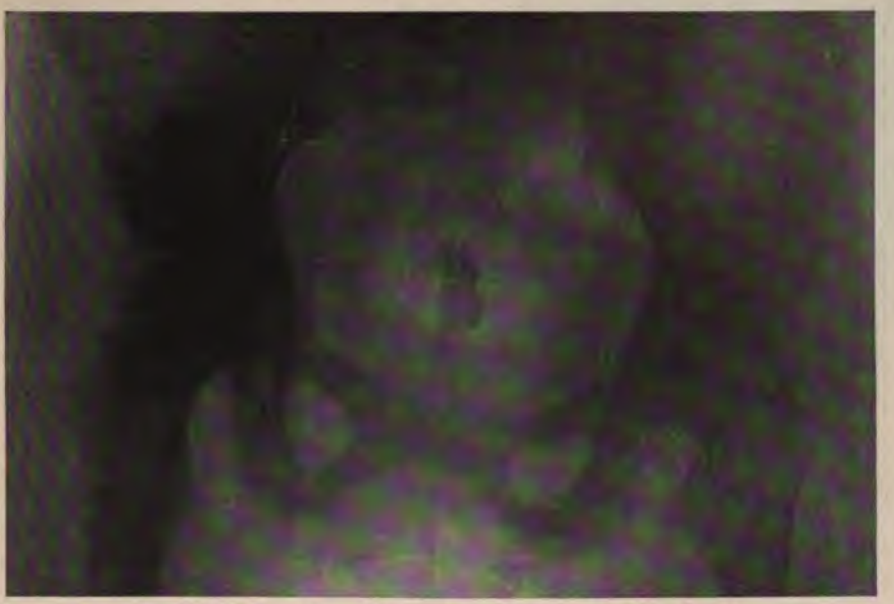

FIG. 411.—Caries of femoral head and acetabulum with tilting of pelvis.

FIG. 412.—Shortening of limb from destruction of acetabulum with pathological dislocation.

tilting of pelvis to relieve strain and to per
also to contraction of the adductors. Rea
of head and neck of the femur and to upwa
acetabulum is absorbed (Fig. 412).

The degree of flexion and of adduction
the well thigh on the abdomen, by which
pensatory lordosis is secured and the dise
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The deviation fro
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Fig. 413.—Late stage of hip disease with ankylosis at right angle. Semi-erect posture only made possible by marked lordosis of lumbar spine. Position greatly benefited by subsequent osteotomy of femur.

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(Fig. 413). The bu
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Induration and Swelling.—The a
hip is best determined by placing the child
necks of both bones simultaneously with fi
thumbs in front of the capsule. The increas

[1] Whitman, Orth. Surg., 3d Edition, 331.

[2] Bradford and Lovett, Orth. Surg., 3d Editio
Mar. 8 and July 5, 1888; McCurdy, Medical Brief, 1

points will be very marked as periarticular induration increases. The inguinal glands if enlarged will add to the induration.

CONSTITUTIONAL SYMPTOMS.—In the early stage, restlessness at night, peevishness, indisposition to being handled, screaming when the diaper is changed, and slight rise in temperature at night will be sufficient to lead to careful local investigation. In uncertain cases the tuberculin test (p. 376) may be employed but is not as reliable as the diagnostic symptoms already enumerated, since other tuberculous foci in cervical, bronchial, or mesenteric glands may exist. Later, with pus formation the temperature variations will be marked and positive.

Remissions.—Relapses are common from even slight injuries or twists of the joint. The author has seen serious relapse after forty-three years of quiescence. Not only are falls and blows productive of a renewal of the process but dancing, skating, etc., in adolescent or adult life will frequently start up fresh symptoms.

FIG. 414.—Double hip disease and ankylosis with legs crossed to such extent that right knee was unable to pass the left in walking. Spine is also twisted to counterbalance. Double osteotomy of femurs resulted in good walking power.

Double Hip Disease.—Diagnosis is more difficult in double hip disease as there is no opportunity to compare the two sides. As a rule, the invasions are not simultaneous. In double cases the treatment is necessarily prolonged and the prognosis as to deformity and ultimate locomotion very serious, especially if both legs become adducted and crossed (Fig. 414).

Diagnosis.—The diagnosis of hip disease in its earliest stage is of the utmost importance since it is the opportunity for the arrest of the invasion. Then and then only can the advance be aborted and a perfect movable joint secured. Every day of delay and every hour of unprotected locomotion add to the danger of ankylosis or of bone destruction. If cases are diagnosed and treated in the first ten days of the infection nearly all will recover with good joints. The chief factor in the production of cripples from tuberculous hip-joint disease is the carelessness of physicians in neglecting to strip and examine children who complain simply of a limp and stiffness about the hip. Another factor, the cause of many deaths and of great deformity, is the absolutely unwarranted assumption by physicians that a pain at the hip in children means RHEUMATISM (p. 374). Rheumatism of a single joint practically never exists in childhood without the positive signs of such disorder. 95 per cent of so-called cases of rheumatism with slight pain, muscular rigidity and intermittent limp, will prove to be tuberculous hip disease.

Since no harm can possibly result from immediate rest to the joint it is strange that so many physicians neglect these cases and load them with salicylates while the tuberculous process steadily creeps on to crippling deformity (p. 325). The diagnosis is usually easy if the fundamental symptoms of MUSCULAR RIGIDITY, POSITION OF THE LIMB (Fig. 415), LIMPING

and REFLEX PAIN are noted, especially if t
and INDURATION. The methods of exam
these symptoms have already been disc
cases the tuberculin tests enumerated on
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With thorough examination, a carefu
suspect the seriousness of the condition a
are complete. In doubtful cases, especi
infants, a second or third examination m
element of voluntary muscular resistance
case should be diagnosed and
invasion of bone tuberculosis

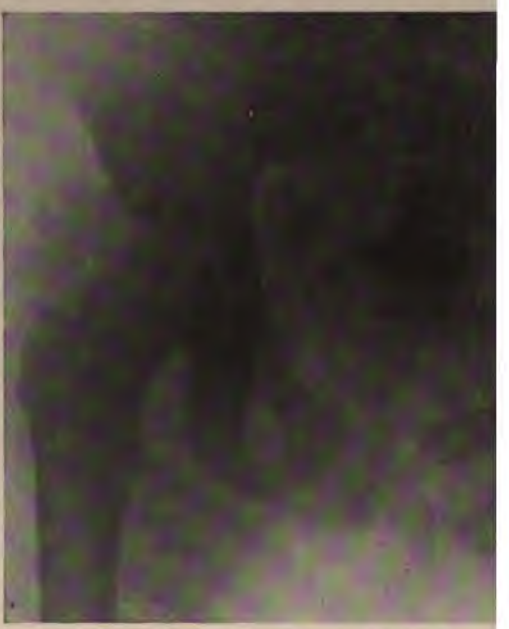

FIG. 415.—Diseased femur abducted and rotated. Compa
on opposite sid

proven itself otherwise. To th
the American legal phrase and say: gui
cent, and thus greatly benefit humanit

The X-ray is of the greatest service i
culous invasion, often revealing a definite f
children the abundance of cartilaginous ti
this test, but taken in conjunction with cl
Foggy, uncertain outlines of the joint are
stages it furnishes valuable evidence as t
tive location of the diseased head of the b
and disappearance of a considerable porti
boy whose only symptoms were limp and s
and rigidity were absent, the hip being fr

Differential Diagnosis.—TRAUMA.—Sprains, strains and contusions will give local pain, tenderness, swelling, sometimes abscess, and a limp; but the history of a sudden onset following a positive injury, the absence of reflex muscular rigidity and pains and of atrophy, will lead to a proper diagnosis. A laboratory or a vaccinal test may assist. PERIARTHRITIS and ACUTE SYNOVITIS frequently follow such injuries but in the former case suppuration is more rapid. In the latter condition time and careful observation will be needed. Fortunately in all inflammatory conditions treatment by REST is indicated.

INFECTIOUS EPIPHYSITIS AND ARTHRITIS.—Infectious epiphysitis in very young infants may occur from a sloughing umbilical cord or other cause. It usually runs rapidly to suppuration and requires prompt inter-

FIG. 416.—Almost total disappearance of head of femur, with absence of all signs of hip disease until the condition was disclosed by X-ray.

vention. Infectious arthritis may follow measles, pneumonia, diphtheria or any exhausting disease. It is often mistaken for typhoid fever when the condition is really one of sepsis.

INFECTIOUS GONORRHEAL ARTHRITIS.—This condition is met with in adolescents less frequently at the hip than at the knee-joint. As the existence of urethral discharge is apt to be concealed the surgeon should be on his guard.

SACRO-ILIAC DISEASE.—In sacro-iliac disease the tenderness will be located over the sacral joint, the movements of the hip will not be restricted, and lateral pressure will give local discomfort. Limping and pain will be present. The X-ray will assist in diagnosis. The condition is rare in childhood.

CARIES OF THE ILIUM.—Iliac caries can be distinguished by its local manifestations and the absence of the symptoms of hip disease.

ANTERIOR POLIOMYELITIS.—At the i
sis, tenderness usually exists in the muscle
is sudden. Later the limp is one of weakn
lack of muscular power, exaggerated mo
ity, cold extremity and loss of faradic e
diagnosis clear.

CONGENITAL MALFORMATION.—The
the hip is first noticed when the child b
movable, not
limp is occas
from the slid
femur; the g
lordosed. A
the position o

FIG. 417. — Hip and spinal caries resulting in ankylosis in both regions making locomotion impossible except on crutches. A year later osteotomy of left femur secured an upright position.

FRACTUR
AND SEPARATI
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pain and mu
greatly aid in

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ease of adults.

RHEUMAT
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Rheumatism
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ity is absent.
hip disease wh
early stage is
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SPINAL C
some cases giv
limping and fl
tion of hip-joint motion in caries is only i
while in hip disease, flexion, abduction
Other local hip symptoms will not appea
and possibly kyphosis at some region of
usually arise from lack of accurate exami
in the psoas sheath, distortion may be ext
that spinal pus may burrow through the c
or beneath Poupart's ligament to the regi
hip abscess or secondarily infect the joi
often coexist, resulting in most crippling

BURSITIS.—Inflamed bursæ between the trochanter and the gluteal muscles will produce local pain, adduction and flexion, with flattening of the buttock from atrophy and will obliterate the natofemoral crease. Inflammation of the iliopsoas bursa in front of the capsule will give local pain and flexion.

STRAIN of the ILIOPSOAS muscle may be mistaken for hip disease but flexion of the thigh will relieve pain and rigidity will disappear.

HYSTERICAL HIP.—In neurotic adolescents the diagnosis of real from exaggerated symptoms is often only determinable by repeated careful examinations and the recognition of all the various conditions presented. Expressions of speech in regard to the amount of pain produced by voluntary and involuntary movements will be out of proportion to the accompanying facial expressions, especially if the attention is engaged in other ways (p. 500). Other hysterical manifestations will also exist, muscle atrophy will be absent except from disuse and the X-ray will disclose no caries of joint. The tuberculin test will give no reaction and in the later stages ether will show that there is no bone ankylosis.

Treatment.—The treatment of tuberculous hip disease is the same as that scheduled on page 379, *i. e.*,—

I. Abortive.

II. Hygienic and remedial.
- *a*. Sunshine and fresh air.
- *b*. Medicinal and local; radiotherapy, etc.
- *c*. Bier's elastic passive congestion.
- *d*. Tuberculin vaccination with opsonic regulation.

III. Protective.
- *a*. Rest, fixation and traction.
- *b*. Mechanical.

IV. Correction of early deformity.
- *a*. Gradual.
- *b*. Rapid.

V. Operative treatment.
- *a*. X-ray.
- *b*. Trephining and ignipuncture.
- *c*. Aspiration and injection.
- *d*. Incision, arthrotomy.
- *e*. Erasion, curetting and drainage.
- *f*. Excision, arthrectomy.
- *g*. Amputation.

VI. Treatment of abscesses and sinuses.
- *a*. Conservative treatment.
- *b*. Aspiration with injection.
- *c*. Incision and curetting.
- *d*. Drainage.
- *e*. Sinuses: stimulation and removal of granulation tissue.
- *f*. Bismuth injections.

VII. Correction of late deformity and ankylosis.
- *a*. Forcible correction and tenotomies.
- *b*. Osteotomy.
- *c*. Excision.
- *d*. Arthroplastic fascial flaps for ankylosis.

I. ABORTIVE.—II. HYGIENIC and REMEDIAL.—The abortion of hip disease and its control by sunshine and fresh air are of the utmost importance. For the discussion of these portions of the treatment, the reader is referred to page 380.

FIG. 418.—Extension by weight and pulley on wheeled litter, permitting out-door life. (Merrill.)

The out-door life stands first, since recovery depends entirely upon the amount of inherent resistive force. Food, sunlight and healthy environment are essential. Cure depends largely upon the wise oversight and management of the case throughout many years. Unfortunately, chronic cases are apt to drift from one surgeon to another and rational continuous care is interrupted.

III. PROTECTIVE TREATMENT. — IV. CORRECTION OF EARLY DEFORMITY.—Protective (see p. 394).—(*a*) Rest, Fixation and Traction.—REST to the inflamed and infected hip is the essential element in treatment, not the rest that is obtained by allowing the child to roll about the bed, run through the house, play with companions, and drive the sore head of the femur into the sore acetabulum hundreds of times in the day, but absolute and uninterrupted rest.

RECUMBENCY on a bed or tray or bed-frame or stretcher or on wheeled litter (Fig. 422), with HORIZONTAL TRACTION and the distraction of the

sensitive joint surfaces are absolutely necessary during the painful and inflammatory stage. This lessening of joint pressure is of great service in diminishing muscular spasm, relieving pain, shortening the course of the disease and preventing absorption of acetabulum and pathological dislocation. This rest should be absolute and should continue for *three months after* the disappearance of all pain.[1] It is best accomplished by placing the child upon a bed tray or stretcher splint (Fig. 362, p. 422) from which he should not be removed night or day. This tray or frame, oblong in shape and several inches longer than the child, may be made of galvanized gas pipe one-half to three-quarter inches in diameter, or of bar iron, or hickory wood; or for infants, of bamboo. Across it is stretched canvas or strong muslin laced tightly to the side bars, the two sections being separated several inches opposite the anus to permit cleansing.

HORIZONTAL TRACTION EXTENSION is made by cord passing over a pulley wheel at the top of an adjustable upright attached to the foot cross-bar. This pulley wheel should always have a guard to prevent the rope from slipping from the groove and producing violent jar of the hip. Adhesive plaster lateral strips, extending from the perineum and trochanter to

FIG. 419.—If hip is rigid, horizontal extension by adhesive-plaster strips with weights and pulley increases the lordosis of spine.

a wooden or metal cross-piece below the foot, will give a firm basis for traction (Fig. 419). Moleskin, zinc oxide, rubber or litharge plaster may be varied as borne by different skins. The circumferential binding strips of adhesive plaster should be spirally applied, since a circular band, especially above the heel, may result in tedious ulceration over the tendo-Achillis. The foot as well as the leg and thigh should be bandaged. If the skin becomes irritated, an overgaiter or old shoe with strap beneath the shank can be used temporarily or for night extension. If the strips extend only as high as the knee the continued traction on the capsular ligament will result in elongation and future instability of the knee-joint. The adhesive plaster may also be cut V-shaped, then divided into strips and applied to the leg and thigh. Buckles at the lower extremities can be fastened to a detachable wooden cross-bar. The extension cross-bar should be only sufficiently long to prevent pressure on the malleoli. The amount of weight will be regulated by the comfort secured; from two to ten pounds will usually suffice. In hospitals, iron weights of two pounds (Fig. 418) each are generally used. If night cries do not cease, the weight should be increased or diminished and the angle of extension changed, or

[1] Willard, New York Med. Jour., xlii, 624; Trans. Amer. Orth. Assoc., Sept., 1890, ii, 128.

lateral traction added. In private house
may be easily used for weights. Traction
of the hip deformity (Fig. 420), otherwi
pulley wheel should be lowered one-qu
may be comfortable to hip and lordosed
excoriated under the adhesive plaster, t
rarily maintained by applying a firm gauz
ing and dusting with zinc oxide powder.
are then at once applied outside the banc
skin, another form of plaster should be su
usually less irritating but is not as adhesi
may be successively tested.

FIG. 420.—Traction should be commenced in the line
one-quarter inch daily. Straight extension will give pain a
perineum to prevent stretching of knee ligaments. Pulley

When pain is not relieved by TRACTION
it usually means rapid destruction of bon

Counterextension may be made by
or of the bed, or by perineal straps faste
frame and passing over the abdomen. Sh
are usually needed to maintain the dorsal
from raising its body; or the night-gown a
to the mattress by blanket pins. One gre
the fact that upon it the child can be carri
or placed under the trees with stretcher
Better still, it can be placed upon a whe
continuously night and day in the open a
traction is accomplished by the same exte

frame is used, but does not permit the same amount of out-door life. In hospital wards connecting with a large sun-porch and with beds provided with five-inch wheels, air and sunshine by day and fresh air at night can readily be secured without disturbing the patient (Fig. 151, p. 234).

A plaster bed also makes a firm fixed support (Phelps). A board is cut to correspond to the shape of the body and legs of the child, but longer at the feet and a little wider. The body, legs and the padded board are then enveloped in plaster bandages, making a wooden and plaster bed. The front half is cut away and makes a removable lid for restraining the child.[1] It is especially of value in disease of both hips. Extension may be made by adding foot-pieces. The wire cuirass of Sayre or Bonnet, enclosing the posterior half of head, body and legs, is also effective but expensive.

FIG. 421.—Short spica plaster-cast for fixation of hip. Cast divided along line.

FIG. 422.—Long spica plaster-cast extending from thorax to foot.

In restless cases, additional fixation can be secured in bed by bandaging to the body from axilla to foot a long wooden splint, or by large heavy sand-bags. A plaster hip spica extending from thorax to knee or foot will also fix the hip, or binder's board or leather may be used, or a Thomas posterior bar may be applied (Fig. 423, p. 476).

(*b*) MECHANICAL.—The ends to be considered in the mechanical management of a case of tuberculous hip disease are protection, fixation and traction.

AMBULANT TREATMENT; PORTATIVE APPARATUS. *a* CRUTCHES AND HIGH SHOE; *b* FIXATION SPLINTS; *c* TRACTION SPLINTS.

(*a*) THREE MONTHS AFTER THE CESSATION OF ALL PAIN and acute

[1] Trans. Amer. Orth. Assoc., 1891, p. 82.

symptoms, and especially if out-door life cannot be properly secured on bed-frame or litter, the child should be permitted to move about. Crutches and a protection splint, with a high shoe on the well foot (Fig. 423), and with the diseased leg acting as an extending weight, will permit a moderate amount of exercise in the sunshine and open air. For several years the weight of the body must not be borne upon the diseased joint.

FIG. 423.—Thomas hip splint with posterior bar extending from thorax to leg above ankle, fixing hip and knee. Chest, thigh and leg retaining bands with supporting straps over shoulders. High shoe on well foot; also crutches.

(*b*) Fixation Splints.—Fixation of the hip and its protection from injurious falls and concussions are the methods most frequently employed both in the United States and in Europe. The traction splint is also a protection splint and enforces a certain amount of fixation but not to the extent of immobilization. The latter is known as the American method of treatment and has many able advocates.

Fixation of the hip may be cheaply accomplished by a PLASTER-OF-PARIS spica extending from the thorax to the knee (short spica) (Fig. 421) or to the foot (long spica) (Fig. 422). The body is supported on a pelvic stool (Fig. 166, p. 247) while traction is made upon the limb and maintained until the bandages have thoroughly hardened. Breakage of the cast at the groin may be prevented by inserting longitudinal tin strips between the folds of the bandage and by many reverses and rumplings of the bandages in the groin. Sole leather or felt or binder's board or tin may be used in place of the spica. These splints may be permanent or removable according to the stage of the disease.

A fixation splint is open to the objection that the sitting position is uncomfortable except upon the buttock of the well side and with the body thrown far back, and defecation is troublesome. In conjunction with a rigid splint, crutches and a high shoe on the well foot give excellent protection. In Europe, patients are often allowed to walk about upon a short spica[1] but

[1] Wilson, Trans. Internat. Congress Tuber., Wash., D. C., 1908; Amer. Jour. Orth. Surg., Nov., 1908, 341.

ankylosis and shortening usually result; the benefit lies in the protective fixation, not in the weight-bearing. If steel lateral uprights extending below the foot are incorporated in the cast, ratchet extension may be added.[1]

The best type of ambulant fixation splint is the POSTERIOR BAR OF THOMAS (Fig. 423). This can be constructed by any practitioner and a blacksmith. Malleable iron is better than steel, as it does not spring but retains its shape unless molded by bending irons (p. 567) or by firm hand pressure over a fulcrum. This posterior bar for children should be $\frac{3}{4}$ by $\frac{1}{2}$ of an inch; for adults $\frac{1}{2}$ by 1; should extend from thorax (far enough below the axilla not to interfere with crutches in the axilla) to the lower third of the calf. Four hoop iron strips are attached at right angles to the upright, one to entirely surround the chest, one the lower waist line, one to three-quarter encircle the thigh, and one to half surround the leg. These bands are covered with leather and fastened in front with straps and buckles. The original Thomas splint was fastened by bandages in front. The posterior bar should be bent to fit the deformity of the hip, but should NOT follow the lordosis of the spine. The hip angle of the splint is straightened as deformity lessens. The weight of the limb in walking maintains very considerable amount of traction. A more comfortable splint, Agnew's modification, consists in attaching the posterior bar to a stiff leather corset molded over a cast of the thorax and pelvis. These fixation splints may be worn in bed with traction extension. The more complete and uninterrupted the fixation the less likely is ankylosis or suppuration to occur. Ankylosis is a pathological condition the result of disease, not of immobilization. Unfortunately, absolute fixation of the hip is impossible; if it could be accomplished far more hips would be cured without abscesses and having movable joints. Prolonged rest of a joint is not of itself injurious.[2] If the tuberculous infection can be arrested and mixed infection prevented, the joint will recover with motion.

(c) Traction Splints. Traction and the traction splint are considered to be the typical method of treatment in the United States, but fixation and protection methods by plaster and by bar splints are used by very many American surgeons. Horizontal traction with adhesive strips, pulley and weight during the acute stage, is almost universal; later, ambulatory methods vary with the ideas of the surgeon.

There are many forms of traction splints, based upon the principle of extension, counterextension and lateral traction. The long traction splint of Taylor or of Sayre are types (Fig. 424). The serious objection is that they extend so slight a distance above the hip that proper support and protection are not secured to the joint. This may be partially obviated by erecting a body section extending to the thorax (Fig. 425).

A strong steel pelvic band encircles four-fifths of the pelvis above the trochanters. Two non-elastic padded webbing perineal straps are attached to this by buckles near the lateral borders, so that the straps shall not press upon the vulva or scrotum. These straps are really counter-extending perineal crutches. From the pelvic band extends a strong steel rod down the outer side of the leg and two inches below the sole of the foot. This rod

[1] Abbott and Pingree, Jour. Amer. Med. Assoc., 1908, 427.
[2] Phelps, Trans. Amer. Orth. Assoc., 1891, p. 86.

is provided near the bottom with ratchet extension worked by a key or by set-screw. The lower end of the steel is bent at right angles with the shaft and soled with leather or rubber. To the steel sole plate are fastened two straps for downward traction upon buckles attached to adhesive plaster strips upon the leg. These traction many-tailed straps, of strong moleskin or swan's-down plaster, should extend above the knee to avoid stretching of knee ligaments and should be secured with bandage. The serious objection to adhesive plaster is that it often irritates the skin and also interferes with massage and with cleanliness. These plasters require frequent changing to prevent excoriation, but care, anointing and

FIG. 424.—Long Taylor hip-splint with perineal straps, extension ratchet, and foot plate attachable by buckles to adhesive-plaster strips applied to leg.

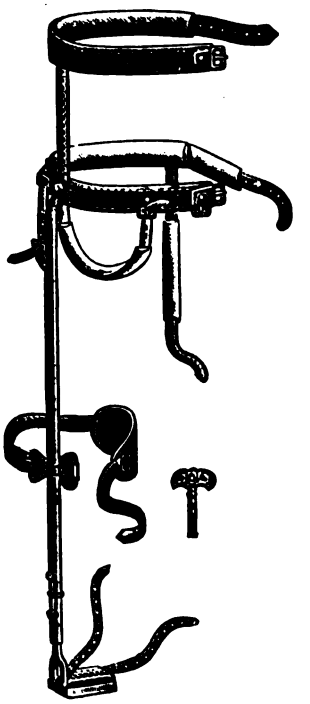

FIG. 425.—Taylor traction splint extended to thorax to secure better fixation at hip.

powdering will guard against ulceration. In place of adhesive plasters, a shoe with buckles on each side facing downward, to be attached to the sole plate straps, obviates this objection and gives an equal amount of traction. The webbing perineal straps are best covered with rubber tubing as it is readily cleansed, but leather or cotton flannel may be used. The perineum must be washed daily and bathed with alum and alcohol, followed by liberal dusting with zinc stearate or talcum powder, until the parts become accustomed to pressure. A portion of each day should be spent in bed with extension. In acute cases the pelvic band should be fixed to the upright, but in receding cases the upright may have a joint and an abduction screw, with backward pull of strap. For hospital use a cheap

form of appliance[1] is made by solid upright bar (Fig. 426). Other are shown in Figs. 427 and 428.

In case of relapse or pain the patient should at once be replaced bed-frame or litter with traction.[2]

In locomotion with crutches and a high shoe on the well fo traction splint adds slightly to the extension produced by the susp weight of the limb, but if used for walking it fails to prevent conc of the joint for the reason that at the vital moment when weight is b

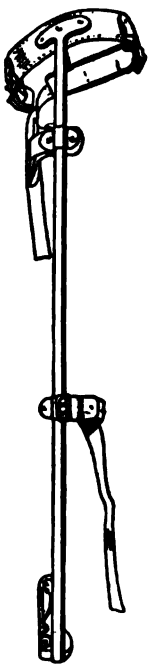

FIG. 426.—Upright solidly fixed to pelvic band. (Thorndike.)

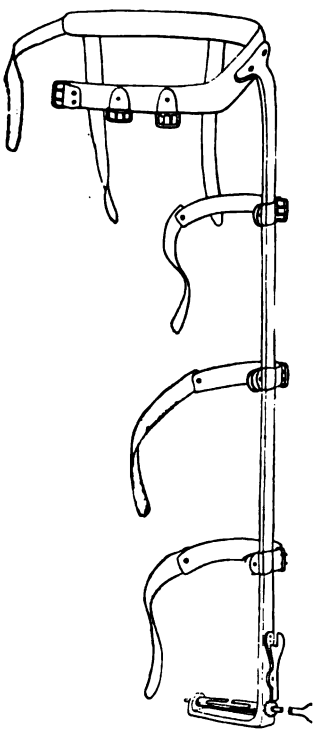

FIG. 427.—Another form of hip splint with extension at foot and perineal strap

to bear upon the perineal straps the ankle straps are loosened. F with adduction and limited motion is the usual result after ye treatment.

LATERAL TRACTION. — When more absolute immobilization o joint is necessary it can be accomplished by traction, not only i line of the femur but also by lateral traction in the line of the nec also by fixation from thorax to foot, together with the use of cr and high shoe.

Every splint requires for years the close supervision of the su A case recently came to the office wearing a Taylor traction spli

[1] Thorndike, Trans. Amer. Orth. Assoc., Sept., 1893.
[2] Brackett, Trans. Amer. Orth. Assoc., vol. ii, 207.

which the knee retention had been secured of a wide pad. This webbing had not pass it and had so absorbed the internal vast extended to the bone to the depth of two fi

Convalescent Splints.—A YE DISEASE have passed, cautious testing of th begun. While still walking on crutches and a little weight may be progressively borne u Later the most comfortable protective splin The in st over are

FIG. 428.—Hip splint extending to chest. Knee-cap should fit over condyle, not over muscles of thigh.

by a joint attached to two steel Y-shaped a movable drive bolt and socket this j clothing during locomotion, and unlocked a much more comfortable position than This splint protects the joint during wa pressure from the hip and only allows mot The Taylor convalescent hip splint is conservative treatment are seen in Figs. 4

[1] Willard, Convalescent Hip Splint, Phila. Me Surg., June 7, 1880.

IV. Correction of Early Deformity—(*a*) Gradual.—If the deformity is due only to the reflex muscular spasm, it will slowly disappear if horizontal traction is made in the line of the deformity and the change toward the straight line made slowly and persistently. The surgeon must not be deceived by the compensatory lordosis (Fig. 419, p. 473).

(*b*) Rapid.—In the hands of a cautious surgeon, partial, slow, careful correction of the flexion and adduction may be made under anesthesia, but all violence is dangerous, as fresh inflammatory troubles may be added. After this operation a plaster spica should be at once applied in the corrected position.

Fig. 430.—Result of conservative treatment. Caries was well advanced when patient was first seen. Slight adduction and shortening.

V. Operative Treatment.—If the diagnosis has been made early in the infection and conservative treatment by rest and fixation thoroughly applied at the onset of the disease, operative treatment will seldom be required, as these cases will recover with good movable joints (Figs. 432, 433). In private practice operation is rarely needed when the case has been seen early by a careful orthopaedic surgeon. In neglected cases coming late to the surgeon, long treated for rheumatism and other diseases, in extremely painful involvements, in mixed infections and severe suppurations, in adolescents, and in waxy internal degenerations, operative measures will often become necessary to save limb or life.

Fig. 431.—Good walking results secured with fair motion and but slight deformity after two years of fixation with Thomas bar splint, and the use of crutches on well foot. Sinus in left groin discharged for six months. Adduction straightened by tenotomy of adductors followed by gentle abduction.

The selection of cases requiring operation is a difficult question even with the aid of the X-ray, and will demand the best judgment of the surgeon and a careful consideration of all the conditions existing in the individual case. In the present state of our diagnostic knowledge it is exceedingly difficult to decide early which cases will progress to recovery and which will become suppurative and destructive. Undoubtedly if the latter cases could be thus selected, an early operation would save many lives and prevent much crippling deformity. X-ray shadowgrams are of service, but in young children the bones are so cartilaginous that accurate conclusions are not easily reached.

Increasing rise in temperature will always lead to a suspicion of pus formation and mixed infection. Palpation will often detect a deep elasticity in a certain area of the periarticular induration, provided the finger

pressure is made IN THE LINE of the muscles, not across their fibres. Pain and local tenderness will be increased. The escape of pus from the capsule may be indicated by a change of position of the femur from abduction to adduction. The direction taken by the pus will depend somewhat upon its point of origin, more upon the resistance that it encounters (Fig. 434). It may make its way forward above Poupart's ligament, especially if the acetabulum is involved. It may work directly forward from the joint, inward to the adductor region (Fig. 434), outward above or below the trochanter, downward in front or to the outer side of thigh (Fig. 435); backward into the buttocks or rectum. In long-continued suppuration, a dozen or more sinuses may exist.

FIG. 432.—Amount of inward rotation secured after conservative treatment of hip disease. (Young.)

FIG. 433.—Amount of flexion secured after conservative treatment of hip disease. (Young.)

When inflammatory elements have not been added, the tuberculous infection may become encapsulated and caseate or liquefy. Even when large destruction of head, neck and acetabulum has occurred, visible signs of pus may never present themselves. Occasionally a large tuberculous mass of tissue will slowly make its way to the surface. If mixed infection takes place after opening, suppuration will be greatly prolonged and the sinuses will persist even after bone caries has ceased (Fig. 436). Schwatt[1] summarizes his excellent article by stating that the treatment of a sterile abscess should be protective and hygienic; that neither prompt eradication of all abscesses nor the let-alone policy should be indiscriminately followed but that removal of pus is advisable in selected cases.

[1] Schwatt, Inter. Clinics, vol. ii, Series 19, 177.

(*a*) X-ray.—The advantage of the X-ray in determining the amount of disease is very important, as has been set forth on page 6, but as a therapeutic agent the rays have not proven of much service.

(*b*) Trephining and Ignipuncture.—When it becomes possible by the clinical symptoms, plus an X-ray delineation, to diagnose with accuracy the exact tuberculous focus, the early trephining and gouging—focal extirpation—of an entire articular focus in neck or trochanter

FIG. 434.—Hip abscess appearing in upper adductor region of right thigh.

FIG. 435.—Abscess appearing at outer region of right thigh.

will be helpful.[1] At the present time, unfortunately, accuracy is still impossible and the operative surgeon will find conditions that will modify his previous conclusions. A skiagram though often useful is just as often misleading.[2] With tenderness over the trochanter or at the base of the neck and absent over the joint, with clean-cut articular surfaces and with a definite light spot as shown by the radiogram at this area, a one-fourth inch trephine opening may be made from the outer side of the trochanteric

[1] Huntingdon, Amer. Jour. Med. Sci., July, 1905.
[2] Sherman, California State Jour. of Med., March, 1907.

surface, the instrument being carried in along the line of the axis of the neck until the area is reached; then a small curette may be used to clear away the diseased tissue, and tincture of iodine injected. The wound can be closed loosely without drainage if thorough asepsis has been employed. The unfortunate part of trephining is that it is impossible to decide absolutely that all diseased tissue has been removed, hence recrudescence and extension of the disease is not uncommon.

FIG. 436. — Suppurating sinus in left upper gluteal region with shortening of limb from bone destruction.

Tunnelling and cauterization of the longitudinal axis of the neck of the bone—ignipuncture — is similar in its procedure to trephining but is subject to the same uncertainties of complete removal. It is possible that the actual cautery so frequently used in former days for the treatment of this disease sometimes penetrated the bone and in addition to destroying the bacilli, required so long a period of subsequent rest that benefit resulted.

(*c*) Aspiration and Injection.— Early aspiration sometimes prevents suppuration. If cleanly done it is a safe operation. A strong needle of large size may be entered in front of the joint, halfway between the anterior superior spine and the femoral artery, or in the rear. The early withdrawal of fluid and its bacteriological examination are important.

Various injections have been employed in tuberculous hip disease. While there is no serious objection to their use the experience of the author is that they exert but little influence upon the course of the infection. Iodine, formalin 2 per cent. in glycerine, iodoform in sterile oil or glycerine, carbolic acid, and zinc chloride have been used (p. 396). These substances have some power in destroying bacilli but they act chiefly as foreign bodies arousing and stimulating the resistive powers of the region. In the effort of the repelling cells to rid the area of the intruder, the infecting tuberculous elements are incidentally destroyed in the hyperemic process.

(*d*) Incision or Arthrotomy.—If the shadowgram shows ragged irregular outlines on either face of the articular surfaces (Fig. 437), especially if pain cannot be relieved by extension with traction and fixation, early incision, erasion or excision is indicated.

When mixed infection is proven by clinical and bacteriological evidences, the abscess should be opened by incision at the lowest part, the cavity flushed with bichloride solution, injected with tincture of iodine or with formalin 2 per cent. in glycerine, and the wound lightly closed. If temperature and other symptoms show disturbance, the stitches should be

(*a*) X-ray.—The advantage of the X-ray in determining the amount of disease is very important, as has been set forth on page 6, but as a therapeutic agent the rays have not proven of much service.

(*b*) Trephining and Ignipuncture.—When it becomes possible by the clinical symptoms, plus an X-ray delineation, to diagnose with accuracy the exact tuberculous focus, the early trephining and gouging—focal extirpation—of an entire articular focus in neck or trochanter

FIG. 434.—Hip abscess appearing in upper adductor region of right thigh.

FIG. 435.—Abscess appearing at outer region of right thigh.

will be helpful.[1] At the present time, unfortunately, accuracy is still impossible and the operative surgeon will find conditions that will modify his previous conclusions. A skiagram though often useful is just as often misleading.[2] With tenderness over the trochanter or at the base of the neck and absent over the joint, with clean-cut articular surfaces and with a definite light spot as shown by the radiogram at this area, a one-fourth inch trephine opening may be made from the outer side of the trochanteric

[1] Huntingdon, Amer. Jour. Med. Sci., July, 1905.
[2] Sherman, California State Jour. of Med., March, 1907.

rongeur forceps, gouges, scissors and knife are needed to secure thorough removal. Sinuses should be followed and their walls entirely cut away. To prevent infection of freshly cut raw surfaces, curetting and the irrigation are done simultaneously with a bulky handled sharp spoon, tunnelled longitudinally with a $\frac{3}{16}$ bore (Fig. 162) and attached by rubber tube to a fountain syringe filled with bichloride solution 1 to 2000.[1] This form of flushing removes the tuberculous material as fast as it is curetted and coagulates the albumin of the freshly exposed surfaces. All pockets capable of retaining pus should be opened. After the free flushings, the cavity is filled with tincture of iodine or balsam of Peru, and the skin edges

FIG. 438.— Erasion of carious foci resulted in cure with but slight shortening and with possible flexion movement beyond the right angle without twisting of spine.

FIG. 439.—Result of erasion with limb in line of body without lordosis of spine and with but slight shortening (see Fig. 438).

of the wound mopped with carbolic acid or touched by the Paquelin cautery. Large rubber or glass tube drainage, gauze packing, thymol di-iodide dusting and a bulky sterile dressing will complete the operation. Rubber tubes should be withdrawn a quarter inch at each dressing until only the mouth of the sinus is kept open. Tubes are usually retained too long.

The child is placed on a bed-frame and horizontal extension applied for six weeks. Splint, crutches and high shoe are used for several years. The erasions may be repeated as necessary. Fig. 439 shows the result of erasion with leg in good walking position.

(*f*) Excision or Resection or Arthrectomy.—When an exploratory incision and investigation of the joint reveals a large area of diseased bone and especially if the acetabulum is involved, an excision

[1] Willard, Jour. Amer. Med. Assoc., Aug. 3, 1895, xxv, 182; Univ. Med. Mag., Apr., 1890.

becomes advisable. The decision between an erasion and an excision must rest with the operator.[1]

In adults, excision should be the rule; in children, erasion is preferable if the caries is moderate in extent and the general conditions favorable. The mortality of the two operations is about equal. In extremely painful cases, unrelieved by traction in the line of the deformity and complete rest, an early excision of the head is advisable, especially if the radiogram shows that the trochanter and shaft and acetabulum are apparently in fair condition. (For technic see p. 398.)

ANTERIOR INCISION (Lucke, Schede, Hueter) does not give as free access to the joint as the lateral cut but is very useful in early resections. It is made along the inner border of the sartorius and tensor vaginæ femoris, or between the outer side of the sartorius and the gluteus medius and rectus. The muscular fibres are separated and the neck of the femur bared, the anterior circumflex artery being avoided. The capsule is opened, the head cleared, the ligamentum teres divided, a curved bone-retractor (Fig. 162, *I*, p. 243) inserted and the neck divided with keyhole saw (Fig. 162, *C*, p. 243). The head can then be extracted with claw forceps (Fig. 162, *J*, p. 243) and the acetabulum gouged if diseased. The joint is filled with tincture of iodine and the wound closed or drainage through a posterior wound is made. This method retains all the muscles, and the author has had final results that permitted balancing of the body on tiptoe of the operated leg.

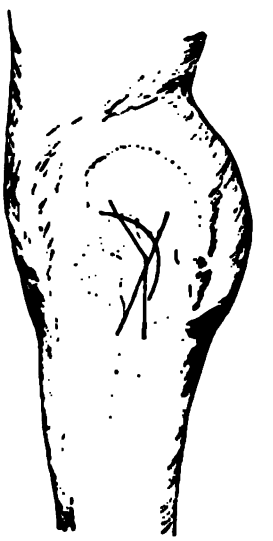

FIG. 440. Lines of incisions for erasion or for excision.

When large bone destruction is shown by the X-ray, a POSTERIOR OR LATERAL INCISION is advisable (Fig. 440). The incision will follow the lines of sinuses, or will extend two or three inches above the trochanter in a curved or S-shaped line over the trochanter, then enlarged on the outer face of the shaft as far as necessary. Usually it is necessary to remove the trochanter to secure good drainage unless a posterior opening is made. The femur should be rotated outward to reach the ligamentum teres (if it still exists) but care must be taken not to fracture the fragile osteomyelitic shaft. If the femur is too strongly adducted, the feebly adherent periosteum may be unfortunately stripped far down the shaft, necessitating a large resection that leaves a useless leg. A strong blunt-pointed knife is useful in clearing the dense infiltrated tissues from the head and neck and capsule. When the bone is raised by a curved bone-retractor it is easily divided with a keyhole saw, which is better than a chain or Gigli saw. The acetabulum, if diseased,[2] is

[1] Willard, Hip Disease, Operative Treatment: Trans. Amer. Orth. Assoc., ii, 134; Hip Excision, Trans. Phil. Co. Med. Soc., 1891, xii, 124; Jour. Amer. Med. Assoc., Apr. 13, 1901, 1015, and 1895, xxv, 182; Phil. Med. Jour., Apr. 20, 1901, 761; Med. News, Apr. 3, 1880, lvi, 361; Internat. Med. Mag., Mar., 1900; Univ. Med. Mag., Phila., 1889, 359-368.

[2] Gerster, Suprapelvic Elastic Constriction (Momburg) in Pelvic Amputations, Ann. Surg., June, 1910, 878.

curetted or gouged or excised, and carious portions of the pelvis resected (Fig. 441). The author has successfully removed large areas of ilium and ischium, as well as of pubic arches. All tuberculous tissues should be trimmed away with scissors, and sinuses laid open and cauterized. After the arrest of bleeding, the wound is thoroughly mopped with tincture of iodine or pure carbolic acid, washed with strong alcohol, filled with balsam of Peru and olive oil equal parts, and packed with gauze around a very large drainage tube carried down to the acetabulum. The recent use of balsam of Peru in wounds justifies the enthusiastic promise

FIG. 441.—Sinuses still remaining after erasion, requiring a second operation.

FIG. 442.—Flexion and adduction after erasion should be prevented by etherization and cautious forcible correction followed by daily manipulations.

given it in former days by the elder Sayre. Freely poured into tuberculous cavities it acts not only as a bactericide, but also mechanically encloses the organisms and favors the deposition of leucocytes, although in some cases it seems to induce albuminuria. The wound need not be sutured except at its extremities and the sterile gauze dressings are tightly applied.[1]

The dressings should be ample. The limb is fixed by a spica plaster-of-Paris splint, or pulley extension with heavy lateral sand-bags may be

[1] Bardenhauer, Annals of Surg., Nov., 1906, 790.

applied. A gas-pipe bedframe (Fig. 362, p. 422) with opening opposite the hips allows subsequent dressings to be made without disturbance of the patient. Sayre's wire cuirass is convenient and excellent, but expensive. A wood and plaster bed (p. 475) also makes a good transportation dressing.

After either erasion or excision, the most careful attention must be given to the subsequent out-door treatment by sunshine and fresh air (p. 380) with the protection and fixation of the joint. The limb should be manipulated daily to prevent adduction and flexion (Fig. 442).

As the operation is a severe one, shock is guarded against by wrapping the entire body in cotton and by the use of the electric heated mattress during operation. Hemorrhage is avoided by the free use of hemostats, hot water, adrenalin, alum, etc.

FIG. 443.—Discharging sinus on inner side of thigh injected with bismuth paste, which paste slowly exudes.

(*g*) Amputation.—In extensive osteomyelitis of the shaft of the femur associated with tuberculous disease of the hip-joint, especially when the acetabulum is extensively diseased, much better drainage is secured by amputation at the joint than by excision.

By the use of *Wyeth's pins*[1] the mortality from hemorrhage has been greatly lessened as the constricting rubber tourniquet can be definitely retained in place. The first long skewer-pin, inserted one-fourth inch below and a little internal to the anterior superior spinous process of the ilium, is pushed through the muscles and emerges behind and above the great trochanter. The second pin is entered from the groin and through the origin of the adductor longus,[2] passes half an inch below the crotch internal to the saphenous vein and emerges an inch below the tuberosity of the ischium. A strong rubber tube is carried around the hip and thigh above the pins. Thomas clamp forceps are also a safe, speedy and convenient means of controlling hemorrhage. The lower sharp blade is carried close to the pelvis beneath the femoral vessels and the forceps then clamped. The posterior vessels are secured in the same way.

Ashhurst's[3] statistics show that the mortality of amputation in hip disease is lower than in traumatic cases (15 to 30 per cent.). Amputation at the hip-joint would undoubtedly be a life-saving operation if oftener performed; especially is this true in acetabular and iliac disease. When preliminary resection of the trochanter has failed to give proper drainage, amputation permits full access to and removal of the carious bone from the pelvis and gives subsequent wide-open drainage. A shortened and insecure leg is often useless after extensive removal of the head and shaft and amputation is better.

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[1] Wyeth's Surgery, 1908, 77.
[2] Willard, Amputation at Hip-Joint for Tuberculosis, Ann. Surg., xxxvii, 456.
[3] Annals of Surgery, 1897, xxv, 127.

VI. Treatment of Abscesses and
abscesses and sinuses has been already thor
also under other operative measures and nee
It is rarely possible to remove all of t
lously infiltrated tissues, consequently, su

Fig. 444.—Bismuth paste injection locating unsuspected sacr
national Clinics, Bloodg

after erasion or after resection so long as
may be induced to heal by occasional curet
open and excising the walls. Other metho
inject it with tincture of iodine or with io
zinc chloride or bismuth. The application
of the sinus will assist in removing diseased

The injection of BISMUTH paste (p. 399) is of great service in outlining the extent and position of the sinuses (Fig. 444, 445). Bacterin therapy as described on p. 390 is often of great advantage.

VII. CORRECTION OF LATE DEFORMITY AND ANKYLOSIS.—Adduction with flexion is the most common position of final fixation of the femur after tuberculous hip disease. This adduction may be gradually overcome during the course of the treatment by persistent, gentle, daily abduction of the limb.

FIG. 445.—Sinuses of hip-joint filled with large quantities of paste causing bismuth poisoning; paste removed with olive oil; recovery. (International Clinics, Rhodgrod.)

(*a*) **Forcible Correction under Ether with Tenotomies** (brisement forcé).—This procedure must be very cautiously accomplished. The long leverage of the femur and the short arm of the pelvis give but little opportunity for fixing the latter during manipulations under ether and great strain is thrown upon the sacro-iliac and sacro-lumbar regions as well as upon the spine, rendering sprain of these parts very probable (p. 451). An assistant must also use care in holding the crests of the ilium that the peritoneum shall not be bruised. Tenotomy of the adductors is usually required. If the pelvis is firmly lashed by bandages to hooks in the floor, as in Allis' method[1] in hip reductions, less injury will

[1] Allis, Trans. Amer. Surg. Assoc., 1907, p. 311.

result. Fixation for two weeks is advisable. Manipulations usually fail to lessen bony adhesions at the hip; and even when a certain amount of motion is secured, re-fixation usually follows within a few weeks unless the patient possesses an unusual amount of courage and patience to continue vigorous motions, voluntary and involuntary, in an orthopaedic gymnasium.

(*b*) Osteotomy. — ONE YEAR AFTER the subsidence of inflammatory conditions with cessation of suppuration and healing of sinuses, a thoroughly sterile osteotomy of the femur between the trochanters (Volkman) or below the lesser trochanter (Gant) should be done to relieve disabling deformity (Fig. 446). Osteotomy of the neck is not advisable; because in the first place the head and neck are often largely destroyed by the disease, and secondly it would bring the site of the operation too close to the quiescent tuberculous area and be likely to arouse fresh trouble. The operation may be done either with a subcutaneous saw (Fig. 162, *D*, p. 243) or with a narrow or broad-bladed osteotome (Fig. 161, *J* and *K*). The instrument is carried directly to the bone at the designated point and the bone cut through by successive taps of the mallet until it can be readily fractured without putting much strength upon the old diseased joint. If the wound requires a suture, the material should be absorbable catgut. Overcorrection of the adduction should then be secured, but backward extension should not be carried to the straight line, as the final ankylosis of the joint would then be very uncomfortable for sitting. Flexion of twenty degrees is more comfortable[1] (Fig. 447).

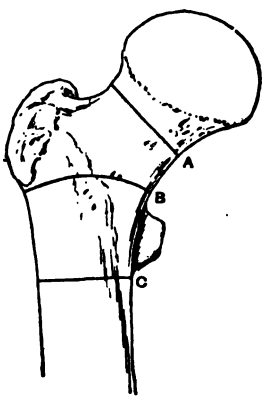

FIG. 446.—*A*. Line of section of the neck by osteotome or by subcutaneous saw (Adams). *B*. Osteotomy between greater and lesser trochanters (Volkmann). *C*. Osteotomy below lesser trochanter (Gant).

A plaster cast extending from thorax to foot is applied (Fig. 166, p. 247), the patient being placed during its application upon a pelvic support to avoid any displacement of fragments (Fig. 448). In so extensive a cast it is necessary to strengthen it at the groin and hip by metal strips incorporated in the plaster and by folds. Over a sterile dressing a generous layer of cotton should be placed especially protecting the sacrum, crest and spinous processes of the ilium, and as the cast is to remain two months or more in position, a longitudinal bandage strip should be inserted next the skin for cleansing purposes and comfort. If neglected at the time, such a strip of muslin can be subsequently pulled through with a double wire. After three weeks, in docile patients, the cast may be sawn off above the knee and the patient placed upon a go-cart (Fig. 364, p. 423) or rolling chair. Crutches are to be used for a month afterwards. The cast may be removed in eight weeks. In cases of ankylosed hip associated with ankylosed spinal caries, great improvement in locomotion can be secured even when the hip has been fixed at a right angle (Fig. 417, p. 470).

CUNEIFORM osteotomy is never advisable, as greater injury to the area

[1] Willard, Longitudinal Osteotomy, Annals Surgery, 1900, xxxi, 641; Trans. Phila. Acad. Surg., ii, 139.

is inflicted, and linear osteotomy is entirely sufficient, the gap being speedily filled with callus and healing takes place as in simple fracture.

In a case of double hip disease seen by the author after eight years of suppuration (Fig. 449), with both hips ankylosed so that knees overlapped each other to such a degree that locomotion was impossible, a SUBCUTANEOUS SAW section of the neck on one side and an osteotomy below the trochanters on the other side, resulted in such excellent locomotion that when seen twenty years later the patient was leading an active life.

(*c*) Excision.—Resection of the head of the femur for the correction of late deformity is seldom practised except when associated with the operation of arthroplasty.

FIG. 447.—Result of osteotomies of femurs below the trochanters, avoiding the diseased and ankylosed hip-joint areas.

(*d*) ANKYLOSIS, PSEUDARTHROSIS, ARTHROPLASTY.—Various attempts have been made to produce a movable joint after ankylosis of the hip from tuberculous (Fig. 450) or traumatic or gonorrheal or infectious arthritis. Inflammatory and infectious arthritis offers greater encouragement than tuberculous cases, as there is always danger in interfering with the latter form of infection.

Interposition of Foreign Substances.—After the removal of the head of the femur, various foreign substances, as gold or silver foil, celluloid, rubber, absorbable plate of bone, ivory, etc., have been interposed between the fragments, but without marked success. Chromicized pig's bladder is the latest and most hopeful substance employed.[1]

[1] Amer. Jour. Orth. Surg., Aug., 1909, p. 1.

Interposition of Muscles and Fascia from Neighboring Tissues. — Murphy and others have endeavored to prevent reunion of the surfaces and produce a movable joint by turning in flaps of fascial and fatty tissue;[1] but while the method has proven advantageous in other joints, yet at the hip it is uncertain.

Fig. 448.—Pelvic support during the application of plaster cast. (Reed, Fig. 166, p. 247.)

Prognosis.—The normal duration of the tuberculous process at the hip is usually two to four years and longer in suppurative cases. Prognosis is largely influenced by early diagnosis and early treatment. In healthy children a tuberculous hip disease can be aborted if absolute rest of the joint is secured in the first two weeks, many cases recovering without stiffening of the joint or deformity. In cases with hereditary lack of resistive power, especially if proper treatment is delayed, destructive caries and suppuration are common. Prognosis is also largely influenced by hygienic possibilities, environment and age. In adolescents and adults the disease is much more serious than in children. Statistics as to actual mortality are unreliable unless cases are followed for at least five years. In the majority of cases examined five years after excision, a limb shortened from two to four inches will be found (Fig. 451). If the results of a large number of operative cases are compared with the results secured by conservative measures, the mortality will be higher and the usefulness of the excised joints less positive in the former by reason of their undue mobility in place of the desirable fixation.[2] The head and neck and trochanters of the bone having been removed, a strong fixed joint is the exception.

Fig. 449. — Ankylosis of both hips with knees overlapping and trunk twisted. Straightened and good walking result secured by osteotomy and by saw section.

Townsend[3] has analyzed 121 excisions, nearly all of which were accompanied by abscesses and sinuses, the acetabulum being diseased in eighteen and with osteomyelitis of the shaft in ten cases. Of ninety-nine ascertained results, 50 per cent. had died within the first year. Only twenty-six could be considered cured as others yet living were still suppurating. Under ordinary out-patient treatment about one-third to one-half of the cases become suppurative. Gibney[4]

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[1] Murphy, Trans. Amer. Surg. Assoc., 1906, xxii, 315.

[2] Townsend, Trans. Amer. Orth. Assoc., vol. x, 66; Sherman, Trans. Amer. Orth. Assoc., vi, 120; Centralblatt f. Chirur., 1894–96.

[3] Medical News, June, 1897, 261; Whitman's Orth. Surg., 3d Ed., 387.

[4] Gibney, Trans. Amer. Orth. Assoc., 1898, 257.

analyzes 150 cases after five years and reports 107 wearing no apparatus and following various occupations.

In the Children's Hospital, Boston, excision was done in 64 out of 1154 cases (5.5 per cent.), with nine deaths, a mortality of 14.6 per cent. The general mortality in 600 hip cases was 4 per cent., chiefly from tuberculous meningitis. The ultimate mortality as far as ascertained was 6 per cent. The percentage of abscesses was 37 per cent. at some period in the disease.[1] Motion of 90 degrees was secured in 20 per cent. of suppurative cases; good motion in 20 per cent.; an absence of deformity and of pathological dislocation in 40 per cent. In non-suppurative cases the shortening was less than two inches in 70 per cent., perfect motion (90 degrees) was secured in 40 per cent.; and absence of flexion and of pathological dislocation in from 60 per cent. to 70 per cent. The ultimate result showed useful walking limbs in nearly all non-suppurative cases. In 100 cases treated by plaster spica and crutches, 69 per cent. suppurated and 30 per cent. required excision. In Germany, the mortality in suppurative cases is reported at 48 per cent.

FIG. 450.—Skiagram of ankylosis of both hips from tuberculous disease.

Estimates vary from 5 per cent. in private practice in cases treated early, to 70 per cent. in dispensary cases and in those treated erroneously for rheumatism and other diseases until suppuration takes place. When treatment is commenced late and mixed infection with pus formation is present, more than one-half will finally perish from meningitis, prolonged drain, exhaustion, lardaceous kidney, liver changes or general tuberculosis. The great discrepancies in the mortality reports are probably due to the after period at which the cases are traced. Many patients apparently cured

[1] Bradford and Lovett's Orthop. Surgery, 3d Edition, 140; Bradford and Soutter, Am. Jour. Med. Sci., Dec., 1908; Lovett, Trans. Amer. Orth. Assoc., 1897, 55.

either by operative or by conservative methods die within five years. In private practice in the United States, when early and efficient treatment can be secured, the mortality is certainly less than 10 per cent.; in neglected and hospital cases seen late, a death rate from 20 per cent. to 30 per cent. may be expected in non-suppurative, or 50 per cent. or 60 per cent. in suppurative ones. The mortality of suppurative cases with pyogenic infection is more than double that of non-suppurative cases. The death rate from osteotomy for ankylosis is practically *nil* and good locomotion is secured (Fig. 452) if flexion and adduction are judiciously corrected.

FIG. 451.—Shortening of leg after excision of hip.

FIG. 452.—Patient standing with weight on right leg and with but little lordosis after a subtrochanteric osteotomy of femur for right angled deformity of hip.

Wright,[1] an earnest advocate for excision, in his 100 cases reports only 17 healed, and 2500 collected excisions place the mortality at 35 per cent.

Dissemination of the toxins by operation favors acute miliary tuberculosis and meningitis. In 837 hip resections reported by Hartman 10 per cent. died from disseminated tuberculosis. Early resections would, of course, give much better results as regards both saving of life and of function, if it were possible even with the X-ray to decide in advance as to which cases would recover under conservative treatment and those which would advance to large bone destruction. Multiple foci of infection and the extremely painful cases are always serious.

[1] Wright, Trans. Amer. Orth. Assoc., vol. x, p. 66.

MORTALITY STATISTICS (Young).

	Non-operative	Operative	Total
	Per ct	*Per ct.*	*Per ct.*
Kiel	49	54	
Marburg	35	40	
Heidelberg	47	58	
Zurich	38	54	
Tubingen	..	..	40
Vienna	..	..	17
Göttingen	..	..	40
Alexandria Hospital	..	..	26
Gibney, United States	..	..	12.5

FUNCTIONAL RESULTS are as a rule not as good after operative treatment as under conservative measures, as there is necessarily loss of bone tissue. Firm ankylosis is a favorable condition for a working man, since a

FIG. 453.—Voluntary flexion possible after excision of hip. (Young.)

rigid hip is more serviceable than a weak, slightly movable one. Movable joints with stability, however, can be secured if the loss of bone has not been great (Figs. 453, 454).

Prognosis is also influenced by the protection given the joint by splint for at least two years after the disappearance of all signs of disease. All

cases require to be kept under close observation for five years. The marvellous recuperative power of certain individuals is shown in a patient of the author's who had already had several excisions, whose hip was riddled with sinuses, and who had large waxy degenerations, yet ultimately recovered under open-air treatment and has continued well for years (Fig. 455). Another case was untreated from the age of five until he was twenty, his parents refusing anything except "christian science treatment."! During these years he walked upon the limb or on crutches. The result was a hip riddled with discharging sinuses, a totally useless limb with shortening of six to seven inches. After majority, when he came under the author's

FIG. 454. — Voluntary dorsal extension after excision of hip. (Young.)

FIG. 455. — Result after excision of both hip-joints.

care, two erasions were performed and large quantities of carious bone removed from the ilium and femur. After three years, with a healthy and active out-of-door life on crutches, although he suffered several extreme traumatisms, suppuration ceased and the sinuses healed.

The functional results after resection will depend upon the amount of loss of bone and of muscular tissue. An early excision with removal only of the head will give an excellent and stable joint. Even in larger excisions, the upper end of the shaft occasionally develops a form of useful articulation with motion, if periosteum is saved. Late excisions below the trochanters necessarily give a shortened limb,[1] often frail and unstable,

[1] Jonas, Western Medical Rev., Mar., 1901.

and requiring the use of crutches and apparatus.[1] Fig. 455 shows excellent walking results after excision of both hip-joints.

In large excisions and in amputations where the entire half of the ilium requires removal, hemorrhage can be controlled by the elastic suprapelvic constriction of the abdominal aorta by the Momberg method.[2]

SUMMARY.

1. Tuberculous hip disease in its early stage is usually slow in its onset and has none of the symptoms of rheumatism. Rheumatism of a single joint practically never occurs in children.

2. The early symptoms of hip disease are limp, muscular rigidity, pain at the inner knee, and flexion. Later, atrophy of thigh, induration, progressive destruction of femur and acetabulum, abscess.

3. The infection can be aborted if diagnosed and treated early.

4. Open-air hygienic treatment is of the first importance.

5. Absolute rest and fixation are essential for a long period of time.

6. Weight-bearing must be avoided.

7. Suppuration is caused by mixed infection.

8. Conservative treatment by mechanical measures usually gives better functional results than operation.

9. Operative measures are necessary in cases that have not been treated early.

10. Alternating bacterin and tuberculin therapy will assist in closing chronic sinuses.

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[1] For prognostic statistics see Young, Orth. Surg., 2d Ed., 340; Whitman, Orth. Surg., 3d Ed., 391; Bradford and Lovett, Orth. Surg., 3d Ed., 140; Koenig, Practical Medicine Series, vol. vii, 1909, 190; Berlin. klin. Woch., Mar. 8, 1908.

[2] Gerster, Ann. of Surg., June, 1910, 878.

CHAPTER XVII.

HIP, VARIOUS SURGICAL CONDITIONS.

HYSTERICAL HIP; PSEUDOCOXALGIA.

THE symptoms of simulated hip disease very closely resemble those of the tuberculous variety, especially when the condition has followed an injury and a certain amount of real muscular and joint tenderness and stiffness has followed long-continued rest of the articulation. The HABIT OF PAIN and of rigid protection of the joint having been established, all motion of the articulation is resisted unless complete anesthesia is secured. The entire group of symptoms of true and of simulated hip-joint disease must be studied as well as the accompanying mental condition of the patient. Spinal and ovarian tenderness and other hysterical manifestations, photophobia, narrowing of the field of vision, changes in color fields and other evidences of nervous derangement may be helpful in diagnosis. The X-ray and the clinical examination will disclose an absence of the typical symptoms enumerated on p. 462.

Treatment.—The surgeon having clearly established the diagnosis must seek out and relieve all physical and psychical causes. The general health must be improved, change of scene and occupation provided, and a wise encouragement of locomotion insisted upon. After etherization, massage and gymnastic movements must be judiciously increased (Traumatic Neuroses, p. 657).

FIG. 456. — Acute epiphysitis of hip from infection after birth.

ACUTE EPIPHYSITIS OF HIP.

Acute epiphysitis of the femur may occur soon after birth by infection from a sloughing umbilical cord or from injury (Fig. 456). An infectious epiphysitis occurs later from typhoid fever, pneumonia or other exhausting disease (Infectious Arthritis, p. 580).

The symptoms will be pain and swelling, with tenderness and flexion. Pus formation is often speedy and septic symptoms intense. A Röntgenogram in adolescents will disclose a diseased focus. Immediate evacuation of pus and erasion of the focus will save from serious infection and give a useful joint (p. 485). Fixation and protection of the joint are essential for many weeks. A plaster-of-Paris dressing is applied from thorax to knee, and thoroughly shellaced to ensure cleanliness. A nursing infant can be best handled if placed upon a muslin-covered light bamboo frame.

FIG. 457.—Trauma of hip with absorption of head and bending of neck of femur resembling coxa vara.

HIP BURSIT

Bursitis may occur in any of the burs
trochanters, beneath the iliopsoas muscle
The cause may be infectious from gonorrhe
genogram will show the absence of hip inv
be localized and there will be no sympton
Suppuration is not infrequently the result,
evacuated, the cavity disinfected with carb

TRAUMA OF

Injury of the hip may result in fract
contusion or sprain, or tear of ligaments.
pain, and tenderness with synovitis and
abscess if infection occurs. The diagnosis
hip will depend upon the history and the ac
but it should al
disease readily f
should be watch
ing of the femor
and absorption
trauma, Fig. 457

Treatment.—
essential, either i
Ice bags applie
swelling. Iodin
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joint should be f
or by binder's b
tective splint (F
as long as there
forms, it should
infrequently foll
correction, or po

FIG. 458.—Ankylosis left hip and right knee from tuberculosis, both corrected later by osteotomies.

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deposits. This
tious arthritis (p
(p. 582), or art
tuberculosis (p. 4
fection, with ank

If FORCIBLE
longed voluntar
muscular exercises fails to secure motion a
tion can sometimes be secured by an arthr

[1] Tr. Amer. Surg. Assoc.,

Arthroplasty.—A long U-shaped flap is turned up above the trochanter. The trochanter major is then sawed through and turned upward, the joint entered and the ankylosed head of the femur chiselled from the acetabulum. A smooth rounded surface is made and the new head manipulated until free motion is secured, since any traumatism after the placing of the fascial flap will risk its vitality.[1] A long flap of fat, fascia and gluteal fibres is cut and turned in to cover entirely the denuded bone surface, care being taken to leave no surface exposed. The flap must be carefully sutured with kangaroo tendon or chromic catgut entirely around the head and under surface of the neck, with the hope of securing a new joint hygroma. The trochanter is wired in position, or better, fastened with an ivory screw with removable brass head. The screw is cut off on a level with the periosteum, as Magnuson has shown that ivory within a bone is slowly absorbed, while any exposed portion acts as a foreign body.[2] A tap is used with thread similar to that of the screws. Drainage should be avoided if possible. The joint should be immobilized with plaster spica for two weeks, after which voluntary and involuntary movements are commenced to secure a movable joint. Gymnastic exercises will be necessary for many months.

Jones[3] recommends the production of a pseudarthrosis without the removal of the head by making a six-inch incision at the upper border of the great trochanter, cutting off with saw or osteotome a slice from the trochanter with its attached gluteal muscle insertion, then opening the capsule and severing the head from the neck by an osteotome. The femur is pulled down and a portion of the neck resected, after which the trochanteric fragment is fixed with ivory screw to the ankylosed head, thus preventing its reunion with the shaft. The operation is not recommended for children.

SLIPPING HIP; SUBLUXATION.

From elongation of the capsular and round ligaments combined with relaxed muscles, the head of the femur without assignable cause may slide upon the upper and outer rim of the acetabulum and return with an audible click. If the subluxation is extreme it may throw the patient to the ground. As a rule, however, the pain while sharp and decisive compels only a short halt, but is followed by pain and discomfort, sometimes effusion for several days. Repeated luxations produce thickening about the joint.

Treatment. Attitudes and exertions that induce the dislocation must be avoided and the hip muscles strengthened by voluntary and involuntary gymnastic exercises and massage. If knock-knee or flat-foot coexist, a change of tread is helpful. A tightly laced girdle encircling the trochanters is of service (Fig. 392, p. 453), or a hip splint (Fig. 429, p. 480) may be worn. Tip-toe walking is beneficial. If the slipping occurs frequently and with serious results, an open operation with plication of the capsule may

[1] Murphy, Transactions Amer. Surg. Assoc., 1906, Jour. Amer. Med. Assoc., May and June, 1905.

[2] Magnuson, Univ. of Penna. Med. Bull., May, 1908. (These screws are made by Schneyder and Allen, Philadelphia.)

[3] British Med. Jour., Feb. 29, 1908.

become necessary. Chiselling of a section of the upper rim of the acetabulum, displacing it downward, suturing with gut and applying gypsum fixation for many months is a serious operation[1] and should not be considered unless the disability is great.

RIDER'S STRAIN OF THE THIGH.

The adductor muscles of the thigh may be strained or even torn by a too vigorous grip on the saddle in sudden movements of the horse, or during accidents or falls. Pain at the insertion of the adductor muscles into the pelvis and femur follows, with disability. Exostoses may occur at the lower insertion of the muscle if the periosteum is torn.

Strapping with wide adhesive plaster or the application of tightly-laced leather or canvas belt enclosing pelvis and thigh, will give comfort and promote healing (Fig. 392, p. 453).

LIMPING; INTERMITTENT CLAUDICATION; ARTERIAL SCLEROSIS.

While intermittent limping is often seen in the early stages of joint disease yet the term is especially applied to interference with the circulation of the lower limbs often resulting in gangrene. It occasionally occurs in youth, probably from inherited syphilis. The pain is most frequently felt at the hip or in the calf of the leg, is very sharp, may cease after a short rest but is liable to recur at any time. The pulse in the arteries of the foot is either diminished or absent, the extremity is cold and the toes white or blue. The condition is evidently an arterial sclerosis, or a diffuse obliterative endarteritis, or a vasomotor irritability.[2] The pain in these cases is often primarily referred to flat-foot as the symptoms are very similar. The X-ray may display the thickened arteries. Rheumatism, ostitis, erythromelalgia, and Reynaud's disease should be differentiated.

Treatment.—Treatment will depend upon the cause. If congenital or acquired syphilis is discovered a mixed treatment is indicated, with hygienic measures. Injury, violent exercise, and undue heat or cold should be avoided. Potassium iodide, nitroglycerine, and amyl nitrite are useful. Massage is of little service. Baking sometimes gives relief. Rest is most important either in bed or on crutches. If gangrene occurs, amputation may be at least temporarily helpful.

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[1] Annals of Surgery, xliv, 1906, 791.

[2] Kolmer, Univ. of Penna. Med. Bul., 1908; Arch. Orthop., vi, 262. (A complete monograph.)

CHAPTER XVIII.

KNEE-JOINT TUBERCULOSIS.

Synonyms: White swelling; tumor albus; knee-joint disease; tuberculous osteo-arthritis; strumous arthritis; scrofulous arthritis; fungous synovitis; pulpy or gelatinoid degeneration; caries mollis.

TUBERCULOUS disease of the knee stands third in order of frequency of joint disease, constituting from 2 to 3 per cent. of the cases, the spine and hip preceding it. In so large and complicated a joint, the results are necessarily serious (Fig. 459).

FIG. 459.—Tuberculous knee-joint disease with swelling, flexion and eversion

Causes.—(1) Predisposing; (2) Exciting.—The effect of heredity, age, environment and contagion as predisposing causes, and of traumatism and disease as exciting causes are fully considered under tuberculosis of the joints (pp. 371, 373) and need not here be repeated.

Pathology.—The pathology of tuberculous invasion of the knee is the same as in other joints (p. 368). The essential point to be kept in mind is that the primary condition in children is an epiphysitis or ostitis and that

FIG. 460.—Erosion of cartilage and bone in knee-joint tuberculosis.

FIG. 461. — Deposit of tuberculous infiltration within and around the knee-joint.

FIG. 462. — Tuberculous infection of femoral condyle.

the primary synovial type is uncommon. The tuberculous osteomyelitic process advances from the epiphysis, perforates the joint, setting up synovitis, erosion of cartilage (Fig. 460), ligamentous destruction, pulpy degeneration and deposit of tuberculous granulation tissue within and without the joint (Fig. 461).[1] Gelatinoid thickening of tissues, subluxation, abscess and death frequently follow. The process may begin in the femoral epiphysis (Fig. 462), or in tibia, patella or fibula. If the knee tuberculosis is secondary to a tuberculous focus in another part of the body, the plugging of an artery in the epiphysis by an embolus may give a wedge-shaped sequestrum from infarct.

FIG. 463. — Flexion and muscular spasm at knee, with effusion and induration.

FIG. 464. — Flexion of knee, with alteration of contour.

[1] For microscopical appearances of bone and joint tuberculosis see Frontispiece. Dr. Major was fortunate in a single slide to discover so many essential elements of bone infection.

Symptoms.—An insidious intermittent but persistent and increasing limp following a slight injury of the knee, recent or remote, and with flexion and muscular rigidity of the joint in childhood should always be regarded with suspicion. If immediately, in the first ten days, treated as a case of commencing tuberculous knee disease the process can be aborted. Hundreds of children are yearly crippled or lost through the ignorance and carelessness of physicians who thoughtlessly treat the case for months as one of rheumatism while the tuberculous process creeps steadily on and the opportunity for arrest is lost.

FIG. 465.—Tuberculous disease of right knee and of left hip. Both straightened later by osteotomies.

The limp, fatigue and stiffness will be the first symptoms noted. Muscular spasm and flexion will speedily follow (Fig. 463) and are the most reliable of all the symptoms of tuberculous invasion, although not quite as persistent as in hip tuberculosis. Even in early stages there will be a visible change in the contour of the knee when compared with the opposite one (Fig. 464), the depressions on either side of the patella being obliterated by swelling or effusion. The sensitiveness and pain will be greatest over the infected focus, usually at the internal condyle of the femur. This pain will increase with the advance of the process until it may be severe and starting, especially at night, from alternate muscular relaxation and contraction in sleep. As the disease progresses the destruction of the joint (Fig. 465) and the boggy infiltration without, both increase, the skin becomes tense and pale and the typical waxy WHITE SWELLING OR TUMOR ALBUS appears (Fig. 466). During inflammatory exacerbations from injuries, heat will be noticeable both by the surface thermometer and by the hand, but in the boggy tumor-albus stage the skin is cold and shining. The fixation becomes more positive as the muscles attempt to lessen pain by preventing motion. As ligaments are destroyed, backward subluxation and outward rotation of the tibia take place from contraction of the biceps (Fig. 467). Disorganization, abscess and extensive suppuration follow. In the latter stage long-continued suppuration often leads to death. Tubercle bacilli can sometimes be discovered in the pus; frequently they are dead, but toxins remain and can be inoculated into guinea-pigs. Milder cases (Fig. 468) may end in recovery with or without motion (caries sicca).

Differential Diagnosis.—Early diagnosis in knee tuberculosis is absolutely essential as prognosis and treatment are entirely dependent upon it. The frequency of tuberculous disease in children should cause every doubtful case to be treated upon the basis of infection until permanent cure is assured. The great producer of cripples is the practitioner or sur-

geon who carelessly passes over a limp and a pain as a "habit," or as rheumatism. Children prefer to play, not to limp. In diagnosis the burden of proof in chronic disease of the knee in a child should always rest upon the non-tuberculous side of the question, since infinite risks are involved by delaying proper treatment (p. 467). The X-ray will often show a diseased focus in femur or tibia (p. 374).

CONTUSIONS and SPRAINS will be speedily followed by pain, tenderness, possibly by effusion, but under rest and fixation the symptoms of acute synovitis will speedily disappear. In acute effusion the patella will usually float when the knee is straight. It is important to remember that even a

FIG. 466.—Typical white swelling or tumor albus.

slight trauma may become the exciting cause of tuberculous degeneration, consequently an injured knee should be watched for several months.

RHEUMATISM.—The most blameable and unjustifiable diagnosis and the one resulting most seriously is that of rheumatism. Rheumatism of a single joint in childhood is practically never seen[1] without the positive signs of fever, heat and sudden swelling, sweating and cardiac lesions. Tuberculous disease is usually slow, insidious as to limp, pain and swelling, but muscular spasm and flexion appear early (p. 462). To treat a case of rheumatism by rest and fixation and general constitutional measures can do no possible harm, while the opposite method results in hundreds of cases of crippling deformity or death. Aspiration of the joint fluid and inocula-

[1] Willard, Penn. State Med. Jour., Mch., 1910, 425; Internat. Med. Mag., Mch., 1900.

tion of guinea-pigs will definitely settle the question if the clinical symptoms are obscure. The tuberculin tests (p. 375) should be used, but are uncertain.

CHRONIC SYNOVITIS from repeated injuries, slipping of loose bodies etc., are discussed on page 530. A careful examination will be required and all such cases must be closely watched lest tuberculous invasion follow.

PERI-ARTICULAR INFLAMMATIONS and bursitis will have their distinctive histories, with symptoms of localized extra-articular tenderness and speedy abscess (p. 535).

FIG. 467.—Backward dislocation of tibia from destruction of ligaments.

HEMORRHAGE INTO THE JOINT.—In "bleeders" this oozing may occur on slight injury, in other cases only from severe traumatism.

HYSTERICAL JOINT. — Although tenderness, pain and stiffness are readily simulated, yet the case if seen late will present none of the positive symptoms of tuberculous disease, and ether and the X-ray will materially assist in diagnosis[1] by showing the absence of either bone or cartilage destruction (Traumatic Neuroses, p. 657).

ARTHRITIS DEFORMANS.—Osteo-arthritis is more common in adults and will present the symptoms of bony deposits and grating in several joints.

[1] Willard, article in Warren-Gould Internat. Text-Book of Surgery, vol. i, 721.

ACUTE INFECTIOUS ARTHRITIS, EPIPHYSITIS, AND OSTEOMYELITIS will be rapid and destructive in their course, with chills, high fever, and other septic symptoms, demanding immediate incision (p. 581). By laboratory examination the micro-organism will be demonstrated by the microscope or by bacteriological test.

GONORRHEAL ARTHRITIS will in addition to the urethral infection and the presence of diplococci show earlier limitation of motion and the symptoms will be acute (p. 582).

SPINAL ARTHROPATHIES. In the absence of known existing locomotor ataxia, the lack of pain and of muscular spasm, with progressive effusion and destruction of the joint, will be indicative.

SARCOMA.—Malignant disease of the femur or tibia will at first confuse the diagnosis, but will progress with greater rapidity, resisting all treatment, while the joint may continue movable. The tumor may lift the popliteal artery so as to simulate aneurism. The X-ray and the microscope will be helpful assistants as will also the use of tuberculin (Figs. 530 and 531, p. 602).

[illegible]

Prognosis.—The prognosis depends entirely upon early diagnosis and efficient treatment. If the case is seen in the first two weeks the invasion can be ABORTED by absolute rest and fixation. Proper treatment at any time before fibrous ankylosis has taken place will probably result in a cure with motion in more than one-half the cases, as fixation and protection can be more readily applied at the knee than at the hip. If seen late limited motion and partial or complete ankylosis are to be expected if the case has been maltreated for months for rheumatism. Suppuration occurs in one-third to one-half of the cases, in which event ankylosis may be predicted. In severer cases even after excision or amputation death often results. In other severe cases, however, ankylosis, right-angled deformity (Fig. [illegible]) and [illegible] may take place without suppuration. Death occurs from prolonged suppuration, or from amyloid disease, or general tuberculosis. Suppurative cases rarely reach middle life.

Relapses frequently occur unless protection is continued from two to five years. The mortality is from 10 to 15 per cent under ten years of age and may reach 40 per cent in later life, the chief cause of death being from

tuberculosis of the lungs in adolescents, or meningitis in children.[1] Koenig's statistics give the general mortality at 22.5 per cent.; Gibney[2] 8.6 per cent. Erasion rather than excision or amputation is to be recommended in children to secure continued epiphyseal growth and lengthening of limb. In adolescents as in adults the more radical operative measures will be necessary.

FIG. 469.—Right-angled deformity from tuberculosis of knee. Straightened later by tenotomy of hamstrings and osteotomy of femur.

Treatment. — The treatment of tuberculous knee disease is similar to the course pursued in other joints and is outlined on p. 471.

The various rational methods of treatment are fully discussed under Tuberculosis of Joints (pp. 379, 380) and need not be here repeated, except as specially applicable to this joint. Nos. I, II, III, and IV are there shown to be more essential than No. V (pp. 380–395).

FIG 470.— Long plaster cast from perineum to foot for knee tuberculosis. Opposite ankle also infected.

I AND II. SUNSHINE, FRESH AIR and an OUT-DOOR LIFE[3] even during recumbency are as important as in spine or hip disease (pp. 380, 420 and 472), but ambulatory treatment can be commenced earlier. Bier's elastic passive congestion is described on page 388.

III. PROTECTION.—(*a*) Rest, Fixation and Traction.— Absolute fixation and the avoidance of weight-bearing are more readily

[1] Young's Orth. Surg., 1907, 2d ed., 441.

[2] Gibney, Amer. Jour. Med. Sci., Oct., 1893.

[3] Willard, Open-air Treatment, Jour. Amer. Med. Assoc., July 18, 1903; and Trans. Internat. Congress on Tuberculosis, Washington, D. C., 1908, vol. ii, 257.

accomplished at the knee than at either spine or hip. Rest in bed will be necessary during the acute painful stage, either with fixation or with traction by pulley extension straps in the line of deformity. Partial rest and thorough fixation can be best secured by plaster-of-Paris (Fig. 470), but wood, metal, celluloid, binder's board, silicate of soda, starch, felt or any rigid substance may be used. The advantage of gypsum lies in the fact that it cannot be tampered with by the patient and requires infrequent dressing. Failure to fix the joint with plaster is due to the fact that the

FIG. 471.—Thomas walking knee-splint acting as an ischiatic crutch.

cast is so often misapplied, the portion above the knee being so short that the long lever of the tibia permits constant motion (Fig. 170, p. 249). The thigh portion should extend absolutely TO THE PERINEUM and the leg portion to an equal distance below the knee. In active and rebellious boys the foot should also be included. The first application should be made with knee extended as far as possible without giving pain, each subsequent cast being applied in a straighter position as muscular spasm relaxes. Only a thin layer of cotton and flannel bandage will be required beneath the plaster. When the case is sufficiently quiescent to permit ambulatory

[1] Willard, Knee Injuries and How to Manage Them, Amer. Med., ix, 979, 1905; Joint Diseases, N. Y. Med. Jour., June 23, 1906, 1269.

treatment, crutches with high shoe on opposite foot, or a Thomas knee splint, are to be used, but no weight-bearing is permissible.

(*b*) Mechanical.—The THOMAS KNEE-SPLINT is made with two iron rods extending from three inches below the sole of foot, the inner one to the perineum, the outer to the top of the trochanter. At the upper end these two rods are connected by an ovoid iron ring upon which the patient sits as an ischiatic and perineal crutch (Fig. 471). In measuring, the circumference of the thigh at the perineum and the oblique circumference should be taken at an angle of 45 degrees, allowance being made for padding with felt and basil leather. The posterior circle under the tuberosity of the ischium should bear the greater portion of the weight, as pressure on the ramus of the pubes is apt to excoriate. A more comfortable brace and one more readily adapted is made by flattening the posterior arch and fitting it more accurately beneath the buttock and by making the anterior half

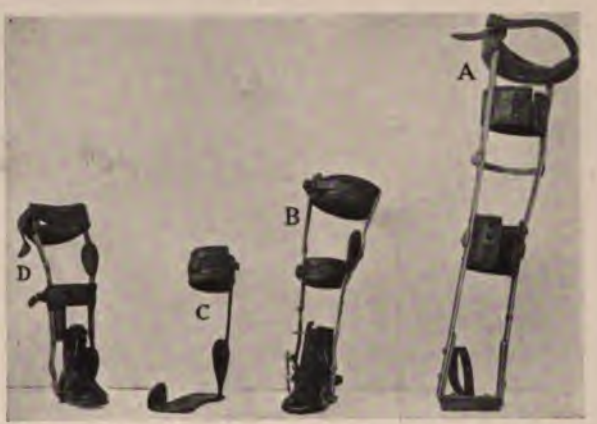

FIG. 472.—*A*, Thomas knee-splint more correctly fitted by flattening rear band and fastenings with strap in front of thigh; *B*, club-foot apparatus, screw adjustment; *C*, club-foot apparatus worn inside of shoe; *D*, bow-leg apparatus for right leg, pads at inner knee and ankle, pad on outer side of limb.

a strong leather strap with buckle (Fig. 472, *A*). The weight of the appliance should be carried by a webbing strap over the shoulder, and a leather sole plate added. Broad laced straps in front of the thigh and leg hold the appliance in place and correct knee flexion. The sound foot must be raised by wood or cork to equalize the length of limbs. The same splint may be made as a CALIPER splint for convalescence, by bending the lower ends of the rods inward at a right angle and slipping each tooth into a tube inserted in the heel of the shoe (Fig. 473). During the early ambulatory stage, axillary crutches should be used, but after the acute symptoms have passed, the splint may be used as a walking ischiatic crutch with locking and unlocking joint at the knee (Fig. 476).

The expensive so-called EXTENSION knee splints are more painful than extension under ether with subsequent fixation, and are seldom if ever required. A Taylor hip splint (Fig. 424, p. 478), or a Lovett's jointed screw and adhesive plaster brace may also be used as a knee protection splint.

IV, V. OPERATIVE TREATMENT.—(*a*) X-ray; (*b*) Trephining and Ignipuncture; (*c*) Aspiration and Injection; (*d*) Incision,

Arthrotomy.—The benefit of these four methods of treatment and their technic have been already fully discussed on pp. 395–398.

CORRECTION OF THE EARLY DEFORMITY.—**Gradual.**—The flexion deformity can be corrected by a succession of plaster casts applied at intervals in increasing extension; or in painful cases, by horizontal TRACTION IN THE LINE OF DEFORMITY made with weight and pulley with slow correction of angle, the knee being supported posteriorly by pillows or board.

Rapid Correction of Early Flexion with Tenotomies.—If the acute inflammatory symptoms have subsided, cautious straightening may be made under ether after TENOTOMY of the hamstring tendons. If the latter precaution is not taken, the leverage may throw the tibia still further backward. The division of the tendons is also of advantage in preventing subsequent flexions. The straightening must be carefully performed, not abruptly, the patient being either on face or back and the tibia protected posteriorly to prevent subluxation. Fixation with plaster in the straightened position for two or more months and protection for years will result in great benefit and give a useful limb. When possible without exciting inflammation, this method saves pain and time and will permit early ambulatory treatment with crutches or fixation appliance. Fig. 474 shows contraction of biceps muscle with rotation and flexion of leg. Fig. 475 exhibits the result after open section of tendon of biceps, correction of rotation and flexion and securing of motion after two years of protection treatment.

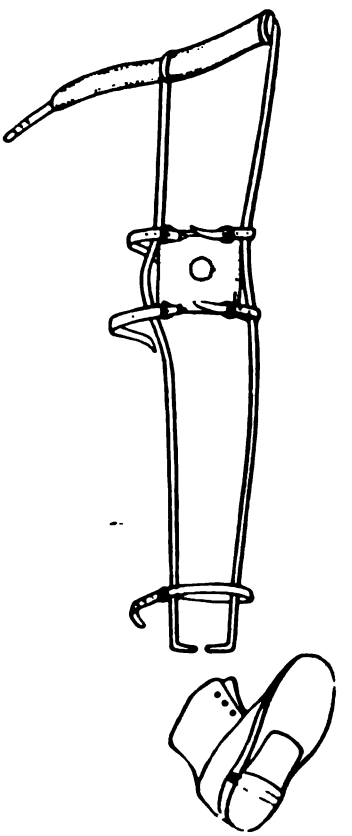

FIG. 473.—Caliper knee-splint. Toothed projections fitting into tubular socket in shoe. (Bradford and Lovett.)

(c) **Erasion**[1] is the operation of choice in childhood unless extensive bone disease is present, even though the operation has to be several times repeated, as time is of slight importance compared with growth. If the epiphyseal line is removed, the limb may be shortened so as to be useless, this shortening, after excision in early life, sometimes amounting to six or eight inches (Fig. 160, p. 241), while by erasion the loss may not exceed one to two inches. A good walking limb, even if ankylosed, may be expected in 80 to 90 per cent. of the cases in children. A single erasion will arrest the disease in at least 75 per cent. of the cases. The mortality following the

[1] Wallace, Amer. Med. Assoc., April 13, 1901, 1015; April, 1895, xxv, 182; Internat. Med. Mag., March, 1900; Internat. Text-Book of Surgery, Warren-Gould, vol. i, 692, 717; Univ. Med. Mag., Phil., 1890, 2459; 1893, vi, 162; Trans. Amer. Orth. Assoc., 1893, vi, 23.

FIG. 474.—Contraction of biceps femoris,

FIG. 475.—Result of open section of biceps
(See Fig. 480.)

two operations of erasion and excision will vary but little. The death rate under five years of age and above twenty will be serious, but the average will be about 10 per cent. About 5 per cent. of erasions and of excisions will ultimately require amputation in adolescents. The most serious results are found when conservative treatment has been too prolonged.

(For additional technic of erasion see p. 396.)

The parts having been thoroughly sterilized and an Esmarch tourniquet applied, the joint is exposed from one condyle to the other by an incision passing below, above or through the patella, preferably the first. The flap being turned back and the knee flexed, every focus of disease in the femur, tibia and patella must be reached with the curette or gouge. The softened and disintegrated synovial membrane is cut away with scissors

FIG. 476.—Convalescent knee-splint, with ischiatic crutch and locking and unlocking drop-catch at knee.

curved on the flat, or with scalpel. The exposure of the joint bursa above the patella will require an extension of the lateral incisions in order to reach every portion of the cavity. Care must be taken at the posterior portion of the joint that the popliteal vessels are not injured. The patella, if diseased, should be removed, as it will no longer be of service, ankylosis being the probable result in all severe infections. The epiphyseal lines are to be avoided as much as possible. After thorough flushing with bichloride, any discolored areas that have not been removed should be mopped with pure carbolic acid, followed by very free washing with alcohol or formalin or iodine. If tuberculous foci escape notice, the wound, even after closure, will reopen. If the Esmarch bandage is removed early and all bleeding points secured, drainage may frequently be omitted, the escape of oozing being provided for by loosely stitching the flap in position and by elevating the limb after operation. Oozing may also be prevented by mopping the joint surfaces with boiling water or with alcohol and acetanilid. The tendo-

patellæ should be sutured with chromicized
ankylosis will be lessened by filling the cavity
closing the joint. In severe cases with free
drainage are inserted at both angles.

FIG. 477.—Bracketed wire splint for use afte

Posterior displacement of the tibia is
ankylosis favored by stitching the fascia with
cized gut and by a posterior fixation splint.
tures, if they become infected, will but add to

FIG. 478.—Frontal section through knee-joint, showing articulatin

removal even years later. The wound is tho
di-iodide (aristol) and covered with a bulky ste
of-Paris casing, before it has entirely hardene
upon inserted removable metal strips (p. 2

[1] Amer. Jour. Orth. Surgery, Oct

quent removal of either anterior or posterior halves for dressing purposes without moving the joint. Windows in the cast are less convenient.

A bracketed splint can be readily made by three angulated pieces of strong iron enclosed in the thigh and leg portions of the plaster splint to bridge the knee and permit access to the region, or a bracketed wire splint (Fig. 477), or a Cabot posterior wire splint may be used. It is very important in applying any dressing that posterior displacement of the tibia be avoided.

(*f*) Excision or Resection or Arthrectomy.—In children, erasion is preferable to excision for the reasons already given (p. 515).

An excision of the joint becomes necessary where lack of early protective treatment and erasion have failed to arrest the disease, or where the bone destruction and suppuration are extensive. As drainage is to be expected, the incisions should commence well back upon the condyles, thus avoiding the necessity for a posterior opening. The advantage of resection in adolescents, or in adults after growth has been attained, is positive and may avoid amputation. The technic, which must be thoroughly aseptic, is somewhat similar to that already described under erasion, save that in arthrectomy more healthy bone is sacrificed than in erasion and the tuberculous synovial membrane is not as fully dissected. A saw is used to remove sections from both the condyles of the femur and tibia. These sections must be made with careful planning as to angles and inclinations that the subsequent position of the limb shall be in proper line. Healthy periosteum should be stripped from the bones, ligaments divided, and the bones protruded by sharply flexing the knee. If a Butcher's saw (Fig. 168, p. 248) with blade reversed is used, the danger to popliteal vessels is lessened. If an amputating saw is employed the vessels should be guarded by a flat protector. In resections in children, diseased areas beyond the epiphyseal line may be gouged (Fig. 478), but in adults these foci should be thoroughly removed even if a second slice is required. Permission for immediate amputation, if it should be deemed necessary, should be secured before etherization.

Fig. 479.—Protective knee support to be worn after erasion or resection.

The joint having been thoroughly irrigated, mopped with carbolic acid and filled with carbolized olive oil, gauze and tube drains are inserted and the tendon sutured, as in erasion. The same form of plaster dressing may be applied, or a bracketed wooden or wire posterior splint (Fig. 477, p. 518) adjusted, as the later dressings should be made to provide for long time drainage and to secure final ankylosis. Drainage tubes should be removed early. Artificial support (Fig. 479) must be given to the joint for two to four years, since even after ankylosis seems secure, subsequent flexion or lateral deformity may seriously interfere with locomotion.

In extreme cases, where speed in operating is of great importance, the bone section must be quickly made, the soft granulations destroyed by carbolic acid, and the joint drained. Shock and loss of body heat will be greatly lessened by enveloping the entire body and limbs in cotton and by using an electric heated operating mattress. As prolonged suppuration from burrowing pus is one of the great causes of death, all sinuses even if extensive should be later slit, curetted, cauterized with carbolic acid and packed. Gluck's ivory knee-joints are foreign bodies and are impracticable.[1]

(*g*) Amputation.—In adults and in adolescents where the X-ray shows extensive degeneration with profuse suppuration, amyloid disease ap-

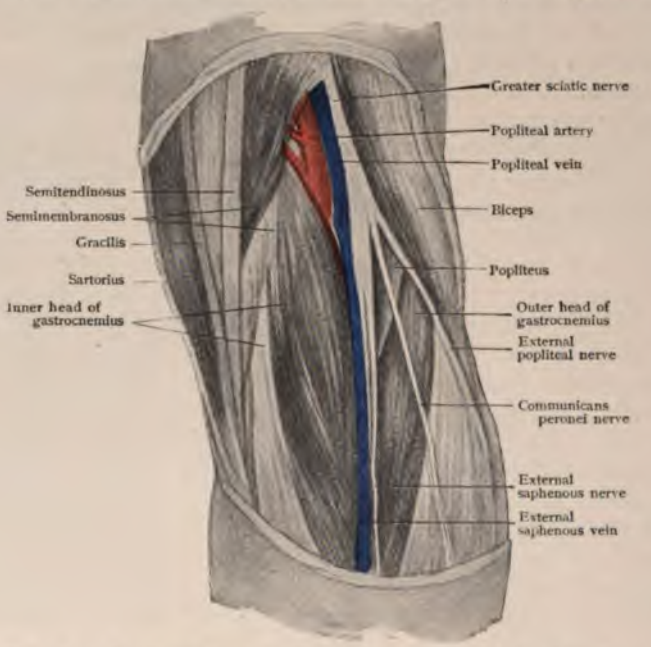

FIG. 480.—Dissection of right popliteal region, showing relation of vessels and nerves. External popliteal nerve lies close to tendon of biceps muscle, and is liable to be injured unless open section is performed. (Piersol's Anatomy.)

pearing, and especially where other tissues are being invaded, amputation is safer, surer and more speedy in its cure than excision. In childhood it is rarely required except as a life-saving operation in extensive suppuration.

VI. ABSCESSES and SINUSES.—The treatment of abscesses and sinuses by (*a*) conservative measures, (*b*) aspiration with injection, (*c*) incision and curetting, (*d*) drainage, (*e*) sinus stimulation, (*f*) bismuth injections, does not materially differ from the procedures already described on pp. 398–400. Removal of the carious bone is the primary element in success, with full attention to the hygienic measures as set forth in the discussion of fresh air (p. 380).

BISMUTH INJECTION is described on p. 399 and BACTERIN THERAPY on p. 392.

[1] Willard, Tr. Phila. Coll. of Phys., Feb. 4, 1891, p. 58.

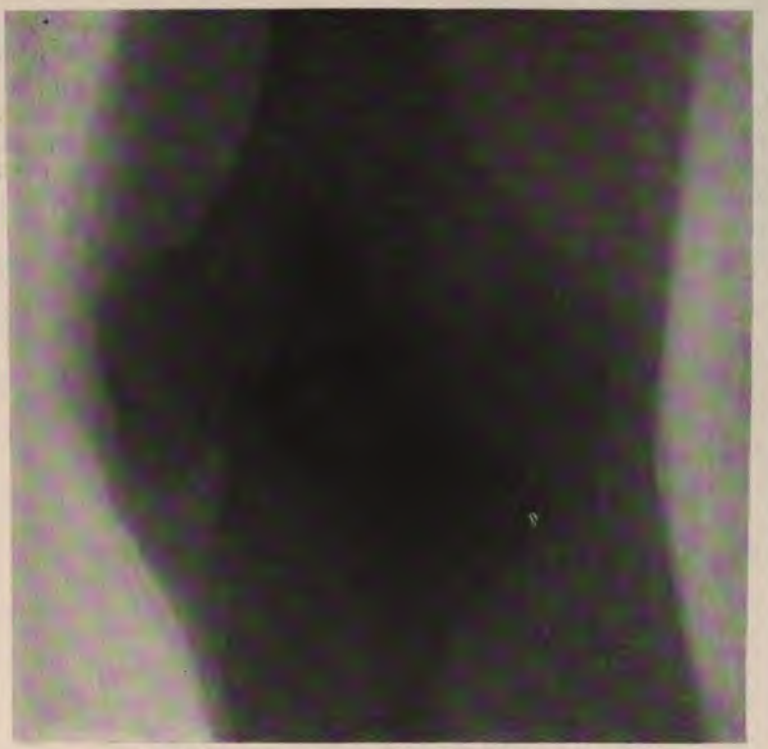

FIG. 481.—Ankylosis from cartilage and bone destruction.

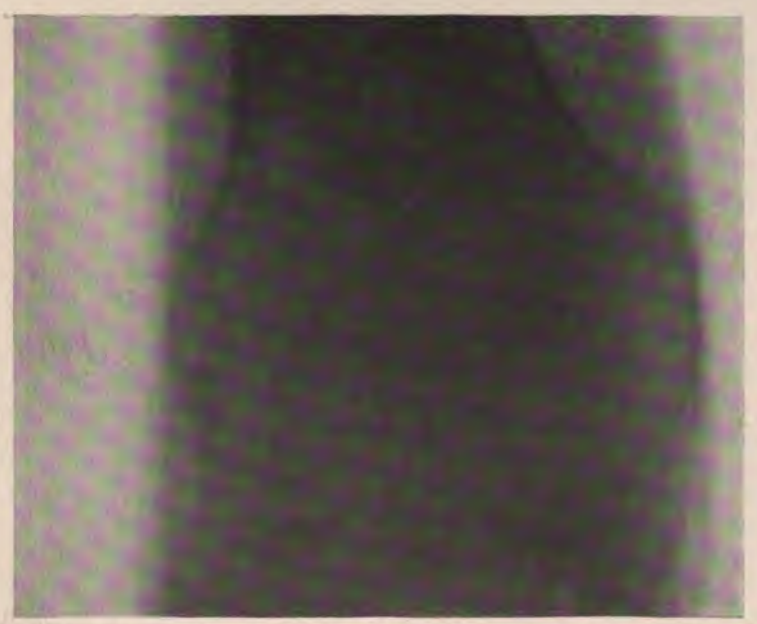

FIG. 482.—Joint surfaces smooth, without erosion of bone. Motion can often be restored to such a joint, even when it is apparently ankylosed.

VII. Correction of Late Deformity—
omy with Forcible Extension.—T
muscles with forcible straightening is the best
but should not be performed until after all
months, lest the tuberculous process be awake
and semitendinosus may be tenotomized sub
tendon, lying as it does so close to the perone
divided by open incision, as not infrequently
also so contracted that it will require divisi

Fig. 483.—A knee-joint with erosion of cartilage and bone shou
tions, as ankylosis is the best atta

speedy healing will ensue. The decision as
to restore motion to a tuberculously disease
consideration by the surgeon of the clinical
case, the degree of fixation and deformity
cartilage and bone destruction as evidenced by
presenting smooth articulating faces without
safely bear quite vigorous forcible movement
roughened and destroyed as in Fig. 483 should
is the best result to be expected. Considera
stretch and tear the contracted fascia, and t
tiously lest popliteal vessels be torn or the

The only accident that the author has encountered was in an old tuberculous knee bent at right angles with added gonorrheal infection, in which case after straightening, an aneurism formed. This was however successfully treated by opening the sac and ligating both ends.

Manual extension is by far the safest method, as the application of a powerful genuclast is very liable to injure soft and hard tissues. The mobilization of the knee in its straightened position will usually give a good walking leg, sometimes with ankylosis, sometimes without. Patients should walk upon crutches for several months with the knee fixed, and an apparatus must be worn for a year to protect the joint from injury and prevent relapse (Fig. 484).

FIG. 484.—Apparatus for protection of knee after straightening.

(*b*) Osteotomy.—Osteotomy of the femur *above the condyles* is a most valuable operation for the correction of tuberculous knee ankylosis. A delay of a year after the cessation of suppuration is advisable. Even when the leg is at right angles (Fig. 469, p. 512) preliminary tenotomy of the hamstrings and forcible stretching followed by osteotomy will bring the line of the leg into good walking position, though a slight backward curve and projection may still exist in the femur. After operation the leg is dressed on fairly straight position, about ten degrees from normal, and encased in gypsum dressing for six weeks. Details of osteotomy will be found on p. 296. With thorough asepsis, osteotomy outside the tuberculous area is safe and beneficial.

(*c*) Excision.—Excision more or less wedge-shaped is indicated in some cases of right-angled deformity where the deposit about the knee is large and the ankylosis bony. The extent of the wedge must depend upon the condition of the parts. The leg should be brought into position ten degrees less than the straight line. Fragments may be fixed with chromicized gut or be held with gypsum, the latter to be worn for six or eight weeks. Wire or nails are foreign bodies, and frequently require subsequent removal (p. 518). The Esmarch bandage assists in the rapidity of the operation and if released early the oozing will be checked by the time the dressings are applied.

POSTERIOR DISPLACEMENT OF THE TIBIA means necessarily that large destruction or stretching of ligaments has already taken place (Fig. 474, p. 516). Force applied with an genuclast is far greater than can ordinarily be safely sustained by the popliteal tissues. Tenotomies and repeated cautious forcible stretchings are sometimes successful, but excision is usually indicated, with the insertion of arthroplastic flaps of fascia. The complicated screw power instruments can seldom be borne (Fig. 485).

(*d*) Insertion of Fascial Flap—
plastic flaps of fascia and fat are more espe
matory or infectious knee arthritis than a
The procedure, if employed for ankylosis
be delayed for at least a year after the su
symptoms.

Great care is essential in the preparation
reception of the flaps. The lateral ligament
bone removed and all unnecessary manipula
order that their vitality shall not be impaire
from the sides of the limb, turned upon thei
in position so as to entirely cover the join
stances have been employed to prevent re-
ankylosis. Sterilized pig's bladder is the
prepared, and is better than a hydrocele sa
rubber (p. 503).

FIG. 485.—Screw-power knee-brace, much more painful an

SUMMARY.

1. Early differential diagnosis from rh
ment are of first importance in the arrest of

2. Mechanical treatment by rest, fixat
either axillary, perineal or ischiatic, are abs
ostitis of the knee during all the treatment

3. In children under twelve years, co
carried to the extreme and all operative p
interference with the epiphyseal lines, to as
In young cases tenotomy with stretching a
be the primary operative procedure, to
necessary and by excision only in severe ca

4. From twelve to fifteen years of age conservatism should still be the rule, although even with operation the chances of a shortened limb are less than in earlier life.

5. Amputation should be rarely employed in childhood, but in adolescents and in adults with extensive degeneration it is often a wise measure.

6. In prolonged suppurative cases with mixed infection the hypodermic injection of pyogenic bacterins alternating with tuberculin inoculations will induce an artificial immunization.

7. After the subsidence of all inflammatory symptoms, late deformity is corrected by tenotomies with forcible correction or by osteotomy or excision or arthroplasty.

8. Excision—not erasion—is properly termed arthrectomy (p. 396). Erasion takes away only diseased tissues; excision removes more or less healthy tissue; amputation sacrifices a still larger area. The ordinary surgeon is too apt to amputate, since it is the easiest and quickest method of disposing of the disease. In the young, time is not of serious importance, consequently erasions, even if repeated, will not only permit growth, but will often save a limb.

CHAPTER XIX.

NON-TUBERCULOUS CONDITIONS OF THE KNEE.

PAINFUL KNEE.

To every consulting orthopaedic surgeon will come scores of patients with knees presenting the uniform history of an injury followed by pain, swelling, effusion and disability. Often months have passed since the traumatism occurred and discovery of the original lesion is impossible. It may have been a simple strain or a severe accident producing any one of the various diseases described on other pages. The pathological conditions observable at the time of examination will vary all the way from a "sensitive knee" to a sarcoma or a tuberculosis. A methodical, systematic and thorough examination is therefore necessary, since no class of cases will tax the surgeon's powers of diagnosis to a fuller exercise of judgment and skill than these injured knees, and will require the use of brain, eyes and fingers to their full extent. The history, past and present, the swelling and tenderness on either side above and below the patella, the amount of mobility, flexion, induration, and of locomotion, as well as the mental attitude of the patient, must all be considered.[1]

The boy anxious to play football next week will describe his symptoms very differently from the chronic neurotic who is desirous to obtain damages from a railroad company. Weakness, disability and pain are conditions that require the closest investigation. Such a knee may be due to a variety of causes, as dislocation of semilunar cartilages, loose bodies, stretching and tearing of ligaments, sprain, strain, pinching of synovial fringes, gonorrheal or septic arthritis and a score of other conditions, resulting in more or less synovitis with effusion. Extreme forcible hyperextension or hyperflexion of the knee by a fall or by a powerful force exerted sidewise upon the knee, as in football playing, may also strain or tear the lateral ligaments and contuse the internal structures. The English comprehensive term of "internal derangement of the knee" covers a multitude of injuries, although usually applied to dislocation of the meniscus. Hyperflexion sometimes so stretches or tears the quadriceps that weakness and atrophy of the vasti follow, especially if an elastic knee-cap has been worn and proper muscle exercise has not been taken. The joint capsule, lacking its normal tension, is squeezed between the bones with resultant pain and inflammation and thickening of fatty fringes. The lateral or anteroposterior subluxation that follows such a condition interferes greatly with the power of rising from a sitting position, the arms being necessary to assist in the movement. The patient also drops suddenly into a chair when he attempts to sit. At

[1] Willard, Knee Injuries, N. Y. Med. Jour., June 23, 1906, 1269; Jour. Amer. Med. Assoc., July 7, 1906; Amer. Med., ix, 1905, 979; Trans. Amer. Therap. Soc., May, 1905.

other times the vasti or the quadriceps may have their power lessened by a tear or strain of the lumbosacral ligaments with subsequent perineuritis (p. 451). The atrophy of the quadriceps is easily distinguishable both to the eye and to the tape measure.

SPRAINS, STRAINS AND CONTUSIONS.

The possibility of an even slight injury of the knee being followed by tuberculous disease, should always be borne in mind, especially in children with hereditary non-resistive tendencies. Injury often results from forced hyperflexion of the knee or from strain as in FOOTBALL injuries, or from twists in TENNIS or other athletic games. The condition may be a simple strain, or it may be any one of many possible injuries of the joint. A careful diagnosis is essential, since so-called sprains are often associated with tear or stretching of ligaments or of tendons, dislocation of semilunar cartilage, fracture, epiphyseal separation, or other severe injuries (Chronic Synovitis, p. 530). If the ligaments are torn, even after the immediate inflammatory symptoms of pain, swelling and effusion have passed, a weakness and disability will remain for months and years and the patient be unable to rise from a chair or the ground without the assistance of his hands.

The capsular ligament may be severely stretched or it may be torn by powerful pressure brought to bear in any abnormal direction. Tendons and fascia will be torn and the pain at the time of injury is sharp, yet under the excitement of sport or accident, extensive laceration will be temporarily forgotten. Effusion is sometimes rapid. In addition to the tearing of tissues and of cartilage, fracture of bones or epiphyseal separation may have taken place, and an X-ray examination becomes necessary. Sprain fracture is not uncommon (Fracture, p. 359).

Treatment.—In a moderate strain or contusion or laceration, the most helpful primary application is wet or dry heat for an hour, the temperature being at the highest limit possible to be borne. Dry heat is applied by an electrically heated bulb or pad.[1] Tight strapping of the joint with adhesive plaster will often speedily remove the difficulty. For more severe injuries with pain and swelling, ice-bags or a rubber coil of ice-water will abort inflammation. Iodine petrogen or tincture of iodine can be applied and the joint put to rest at once in a rigid dressing of gypsum and the patient kept in bed or on crutches. At the end of a week the cast may be removed, the joint moved slightly involuntarily and the casing slipped back in place. At the end of another week the cast can usually be removed entirely and massage commenced. Partial restriction should be enforced by adhesive plaster strapping and the use of a flannel or elastic webbing bandage. Voluntary and involuntary exercises in a well-equipped gymnasium will hasten return to normal motion (Fig. 152, p. 235). Dry hot air (Fig. 320, p. 364) will assist absorption as will also the therapeutic X-ray.[2] Unless there is swelling it is not advisable to continue the knee-cap, as it interferes with motion and nutrition of muscles. A supporting knee-brace will often be temporarily required. A large accumulation of fluid or

[1] Willard, Ann. of Surg., 1910, 643.

[2] Willard, Knee Injuries and How to Manage Them, Amer. Med., 1905, ix, 979.

persistent serum should be withdrawn by a
incision (Synovitis, p. 530). Whenever nece
suppurative infections, especially if septic, th
employed (p. 23).

RUPTURE OF LATERAL

A tear of either lateral ligament, often inc
as a SPRAIN, is a serious injury leading to mo
disability. If seen at once after the injury, i
placed semilunar cartilage by the absence of
the tenderness at one or both points of ligan

Firm strapping is the most acceptable t
by fixation in a plaster cast for four weeks
for chronic synovitis (p. 530).

If the tear is complete and obvious, imn
cized gut gives the best ultimate result. I
surgery of the knee-joint requires greater ca
dominal surgery. Tear of the fascia lata or
insertions of any of the hamstring tendons
disability after even slight traumatisms.

ACUTE SYNOVI

This condition may follow any injury o
Sprains and Contusions. Slipping of loose b
cartilages, foreign bodies (Fig. 486), gout, rhe
or other disease may also be the cause of ac

Should effusion, serosynovitis, hydrarth
uli—water on the knee—occur in a joint
float upon the condyles and the normal lines
with the conformation of the other knee, will
for a floating patella in joint effusion, the kne
position and not hyperextended or flexed.
the patella can be increased by pressure of t
bursa above the patella while the finger of t
the patella.

FLEXION is the rule in effusion, since th
flexly irritated are stronger than the four ext
position gives more space in the joint. B
appears on either side of the ligamentum p
in these locations in women are not to be r

Treatment.—Rest and ice-bags should b
pain persists (Sprains, p. 527). Absorption
by firm pressure of an overlapping series of
in an X manner around the limb exceptir
This dressing will limit motion while not enti

[1] Freiberg, Amer. Jour. Med. Sci., May, 1
[2] Ann. Surg., xlviii, 1908, 726; Amer. Jou

FIG. 486.—Bullet in knee-joint of child. Blood clot at point of entrance. Patella lifted from femur by synovial effusion.

extend well up the lower portion of the thigh to lessen the action of the quadriceps. The adhesive plaster will require renewal once a week; or mercurial plaster may be used. Blisters and iodine are helpful. Cataplasma kaolin at night and hamamelis by day are beneficial. A flannel or stockinet bandage is useful, as is also the pressure of a broad wet sponge bandaged to a posterior splint. In many cases the application of a gypsum cast is necessary for ten days. Massage, hot-air baking, muscular movements, iodine counterirritation or Paquelin cautery will assist in restoration of function. Should the effusion be large and persistent, a sterile aspiration should be performed and a laboratory test made for organisms. Tincture of iodine and sterile glycerine, equal parts, or 2 per cent. formalin in glycerine may be injected. A supporting apparatus and massage of the muscles, with dry heat, should follow. If pus forms, the joint must be opened, washed and drained (p. 532).

CHRONIC SYNOVITIS.

Chronic synovitis is the result of repeated traumatisms, of slipping loose bodies or cartilages, or of bony deposits.

When frequently recurrent, the resultant inflammatory fibrinous deposits and effusion become persistent and the limping and disability great. Ankylosis often follows. Thickening about the joint may simulate tuberculous disease and require the tuberculin test (p. 376).

Treatment.—The essential part of the treatment will consist in the discovery of the cause, in order that injury may not be done by the remedial measures. Appropriate treatment for the especial condition must then follow. During the acute stage and during exacerbations, rest with fixation and the use of crutches should be complete; but it must be remembered that motion is the normal condition of a joint and if unused for too long a period of time, a sensitive or a fixed knee may result (p. 533). Good judgment and careful consideration of all the symptoms can alone decide as to the exact time that rest should be succeeded by cautious motion, massage and voluntary movements. For the absorption of the fluid and indurations, alternate hot and cold douchings and massage and hot dry air baking are of first importance (Fig. 320, p. 364).

The best absorbent agent at our command is iodine. It may be applied to the knee by the tincture, or by iodo-petrogen or iodo-vasogen, or be driven in by cataphoresis. Another reliable application is a mixture of equal parts of the ointments of iodine, mercury, belladonna and opium. Strapping with mercurial plaster is also excellent. Ichthyol has no merit except its odor and its smeariness. Iodoform ointment is vile.

Adhesive plaster strapping, wet sponge pressure, protective support, counterirritation, superheated air, electricity, massage manual and vibratory, the therapeutic effect of the Röntgen ray or of the high-frequency current or the Finsen ray, are to be employed in succession, if necessary.[1]

If persistent, the joint should be aseptically ASPIRATED, irrigated with salt solution and a drachm each of sterile glycerine and tincture of iodine, or

[1] Willard, article in Warren-Gould's Internat. System of Surgery, i, 703.

Lugol's solution of iodine, or carbolic acid solution 3 per cent. injected through the tube and allowed to remain. The injection of two to five drachms of a 2 per cent. solution of formalin in sterile glycerine is most advantageous in promoting absorption of the fluid, since it renders sterile all the constituents of the joint, takes off tension and closes the lymph spaces. As a preliminary to any invasion of the knee-joint, this injection acts most favorably in preventing infection and renders operation a much safer procedure. In contused knee with an effusion of blood and serum, an immunizing injection ten days in advance of any operation permits entrance to such a knee with much less danger of sepsis. This is proven by the injection of streptococci in joints of animals. Wounding of such a joint will be followed by infection, but if the same joint is immunized by formalin the synovial membrane can be punctured and torn with less risk. Infectious arthritis, gonorrheal or purulent, may be treated with advantage in the same way, if liquid is drawn to relieve tension and the joint sterilized by formalin. Extension of the joint by pulley and weight will assist in relieving tension. The injection may be repeated if necessary. A gypsum bandage is worn for ten days. The Paquelin cautery applied freely will also help in absorption. Elastic bandages, or knee-caps, except during the period of needed compression, interfere with circulation and are useful only as reminders. A protective knee brace, limiting flexion and preventing lateral injury, will usually be necessary. If plastic deposits occur, the treatment for ankylosis should be employed (p. 533).

Quiet Effusion.—The term quiet effusion is sometimes employed to denote a painless intermittent effusion into the knee-joint without discoverable cause. It is most frequently found in neurotic young girls with menstrual irregularities. It appears and disappears at somewhat regular intervals and needs constitutional rather than local treatment, and regulated muscular exercises rather than rest.

INFECTIOUS OR SEPTIC ARTHRITIS OF THE KNEE.

The invasion of so large a joint as the knee by pneumococci, streptococci, gonococci or other micro-organisms is usually followed by marked symptoms of profound SEPSIS. It is a serious mistake to diagnose such a dangerous infection as typhoid fever or as rheumatism.

Pain, sensitiveness of the bone and marked constitutional disturbances are usually present and quite frequently there is a serous effusion in the knee-joint itself. An X-ray and a bacteriological examination by the withdrawal of fluid will be useful, but operative measures should not be delayed, as the life of the bone and the life of the patient depend upon early diagnosis and early operation.

Phlegmonous and acute inflammatory conditions in periarthritic tissues can sometimes be arrested by elastic constrictive congestion, with punctures to relieve tension and favor the exudation of serous and infecting organisms, especially if assisted by the application of dry cups (Bier, p. 389).

SUPPURATIVE arthritis should be promptly treated. When suspected by pain and other symptoms, an exploratory aseptic aspiration with bac-

teriological examination may be made if sy
presence of pus is more positive, a large inci
should widely open the joint, which should
per cent. carbolic acid or 2 per cent. forma
or tube drainage.

The infection may result in an ACUTE O
ARTHRITIS.

In young children and even in
recoveries will occur if the poisonous tox
useful limb can sometimes be secured even

FIG. 487.—External condyle of femur destroyed by septic epiphysitis with resultant in-knee.

allow for free irrigations and dressings, th
the thigh. After suppuration has ceased
the constitutional condition is better
SECONDARY EXCISION of joint may save li
rare cases, a mobile joint may be obtai
arthroplasty may be practised later (p. 5

Destruction of the epiphysis of the ou
nent deformity and knock-knee (Fig. 487

[1] Mayo, Ann. Surg., 1895, xxi, 35; Jour. Am
Peck, Ann. Surg., xlviii, 467, March, 1907.

[2] Harrington's solution: Alcohol (94 per cen
sterile water, 300 c.c.; corrosive sublimate, 0.8 gr

KNEE ANKYLOSIS.

Ankylosis is a condition, a result of disease, not the disease itself.[1]

Fibrous or bony ankylosis may follow any of the inflammatory conditions, as chronic synovitis, tuberculous disease, infectious or traumatic arthritis, or slipped cartilage, the discussion of which will be found under their respective headings, with the various operative and mechanical measures to be employed.

To arrive at a decision as to whether a certain case is remediable needs careful consideration of the original cause, the severity of the pathological process and the present condition. Palpation of the joint, the amount of induration, the degree of fixation, the presence of suppuration past or present, the age and condition of the patient, and an X-ray examination must all enter into the final decision. The administration of an anesthetic will often clear up doubt, especially when any neurotic condition is suspected. In non-tuberculous disease without erosion of cartilage or bone, a movable joint may be safely secured by proper treatment; in tuberculous or other degenerative cases, where the skiagram shows marked destruction of bone and cartilage, a permanent ankylosis may give the best walking member that can be obtained under the circumstances, since serious interference with the area will mean a renewal of the process, or infection and death (Fig. 483, p. 522).

In tuberculous cases, the cautions set forth on p. 515 should be carefully noted. Final correction of the deformity should not be undertaken until at least a year has elapsed after the cessation of all suppuration. Supracondyloid osteotomy for right-angled deformity is even then safer than a resection since the resultant bend in the femur is not noticeable under the clothing.

Treatment.—A flexion angle of 5 degrees need not be disturbed. If the deformity is considerable, FORCIBLE STRAIGHTENING WITH TENOTOMY of the hamstring tendons is advisable even during the progressive stage of tuberculous or infectious disease, provided it is done with great caution (p. 515). In tuberculous disease, subsequent fixation with gypsum for a long period of time should of course follow operation. More vigorous *brisement forcé* with tenotomy is required when the acute inflammatory conditions have passed, in chronic, traumatic, gonorrheal, septic or other forms of arthritis. Intermittent force applied with the patient on face or back will accomplish much, while sudden jerks with the long tibia as a lever may tear off an epiphysis, fracture a bone, rupture capsular ligament, dislocate the tibia backward, crush the condyles, or tear the popliteal vessels and nerves. In gonorrheal and many other conditions several etherizations may be required.

The question of placing the joint in a fixed dressing after forcible correction will depend upon whether the joint is to be allowed to ankylose in a more favorable position, or whether an attempt is to be made to permanently restore motion. If the latter, a splint should not be applied for more than a day or two, after which time the patient should be encour-

[1] Willard, Knee Ankylosis, Penna. State Med. Jour., Jan., 1905, vii, 2; Amer. Med., ix, 1905, 979.

aged to move the knee as early as possible. Passive flexions and extensions followed by more active muscular and gymnastic measures and massage, are increased daily.

The technic of excision is described on p. 398, of osteotomy on p. 297. Several operations have been devised for excision without opening the joint.[1]

For the *prevention* of ankylosis after operation, olive oil injected into the joint is most useful. The use of carbolized olive oil 1 : 50 or 1 : 100 for all wounds of both hard and soft tissues was commenced by the author thirty years ago, after he had abandoned the Lister spray. The wounds were filled with the mixture and the results were excellent, but bichloride dressings largely replaced this method. The far less effective iodoform oil has had its day and the trend is now back to carbolic acid. Olive oil may be sterilized in an autoclave by a half hour of steam heat under fifteen pounds of pressure.[2]

As a lubricant and to prevent adhesions the oil is employed pure, but in tuberculous and infected joints iodine, carbolic acid or formalin is added. The oil is poured into the open joint or is injected into the capsule. In partial ankylosis from infectious or gonorrheal disease, arthrotomy, washing and oil injection are most helpful in preventing readhesions (p. 531). Passive motions and voluntary exercises must speedily follow operation.

Arthroplasty.—Murphy's plan is to interpose fascia, muscle and fat between the bones. Other surgeons have used bone, bladder, ovarian cyst wall, celluloid, silver, rubber, magnesium, etc.

A flap cut from the deep fascia of the thigh upon either side may be turned upon its base and inserted between the femur and tibia to prevent reunion after excision or any open operation for ankylosis. Living tissue is much better than any foreign substance.

Since fat is essential as an element in the formation of the cushion for the new joint to be formed,[3] as much fatty tissue as possible should be transferred with the fascial flap (p. 524).

This flap in the case of the knee must be large and long in order to completely cover the articulating surface and also allow for turning over the circumferential edge for suturing, so that no portion of the joint surface shall remain uncovered. At the knee, kangaroo tendon or chromicized gut is used for sutures. If good fascia is not procurable from the external vastus region, an additional flap is taken from the inner side. In order to properly adjust the flap, the anterior and lateral ligaments require to be cut away, which subjects the joint to the probability of becoming too movable. In a working man especially, an unstable knee is far less useful than a rigid ankylosed one. If the patella is fastened it may be chiselled off from the femur. When necessary to remove a slice of bone the section is best made from the tibia. Absolutely free motion of the joint must be secured before turning in the flap, since traumatism of this flap will injure its vitality. The leg should be dressed for two weeks, with weight and

[1] Annals of Surgery, xliii, 1906, 426, and xliv, 800.

[2] Amer. Jour. Orth. Surg., Oct., 1907, 234, and Febr., 1908, 454.

[3] Murphy, Trans. Amer. Surg. Assoc., 1906; Jour. Amer. Med. Assoc., May, 1573, and June, 1671, 1905.

pulley extension or with gypsum, after which time gentle voluntary movements are commenced, followed by passive movements, locomotion and long-continued gymnastic exercises, in the hope of developing a hygroma of the joint.

Transplantation of Joints.—Lexer[1] advocates the transplantation of a section or all of a joint taken from the amputated limb of another patient. He has also inserted between the femur and tibia a large section of tunica vaginalis removed from a hydrocele patient, thus giving a serous joint surface. A piece of omentum might be used or the serous lining of a freshly amputated knee. Prepared pig's bladder has been tried with success.[2] Gluck's ivory joints are useless.[3]

Amputation is too frequently done by surgeons in knee ankylosis, since it is the simplest and quickest plan of treatment, but it is a confession of defeat. It should never be done in childhood for quiescent ankylosis.

KNEE BURSITIS.

The principal bursæ in the region of the knee are seen in Fig. 488.

A bursitis may be developed in any one of these sacs from traumatism or gonorrhœa or other infection. Tenderness and swelling localized to the region of the particular bursa and the absence of the evidences of tuberculous infiltration will be the best guides in forming a diagnosis. Disability and pain will be common to both. Surface thermometry may show a local increase in temperature.

Housemaid's Knee; Prepatellar Bursitis.—Bursitis in the prepatellar sac is met with in children obliged to work in the kneeling position.

TREATMENT.—In the acute form if the effusion is not large it may be removed by firm adhesive plaster strapping or by wet sponge pressure. If more severe and chronic, as the bursa is not connected with the knee-joint, aspiration and injection of tincture of iodine or carbolic acid 5 per cent. solution will be required. Working girls will gain time by having the knee fixed with plaster-of-Paris. In suppurative and infectious cases, free incision, mopping with pure carbolic acid and alcohol, or removal of the sac with subsequent packing and the application of a plaster splint will be necessary.

Pretibial Bursitis.—Inflammation of the bursa between the insertion of the tendo-patellæ and the tibia is not uncommon.[4] Local swelling and tenderness on either side of the tendon will be present, but the soft puffy masses of fatty tissue seen in this situation in nearly all women should not be taken for inflammatory deposits, even though sensitive. If thickened, the induration may resemble periostitis.

TREATMENT.—Fixation of the joint and rest will cure acute cases. The chronic cases are treated the same as prepatellar bursitis.

The large bursa BENEATH THE QUADRICEPS TENDON above the patella does not always communicate with the capsule in infancy but in later life

[1] Jour. Amer. Med. Assoc., July 4, 1908, 85. Amer. Jour. Orth. Surg., Feb., 1909, 575; Med. Klinik, Berlin, May 31, 1908.

[2] Baer, Amer. Jour. Orth. Surg., Aug., 1909, p. 1.

[3] Willard, Trans. Phil. Coll. Phys., 1891, xvi, 58.

[4] Lovett, Boston City Hosp. Reports, 1897, 8th Series.

is usually open. Effusion into this bursa give
the knee-cap in synovitis. Traumatism at
lowed by effusion without lifting of the pat
below. Of the six POPLITEAL bursæ, the sub
municates with the joint, the others occasion
sacs will result in stiffness, pain on extension

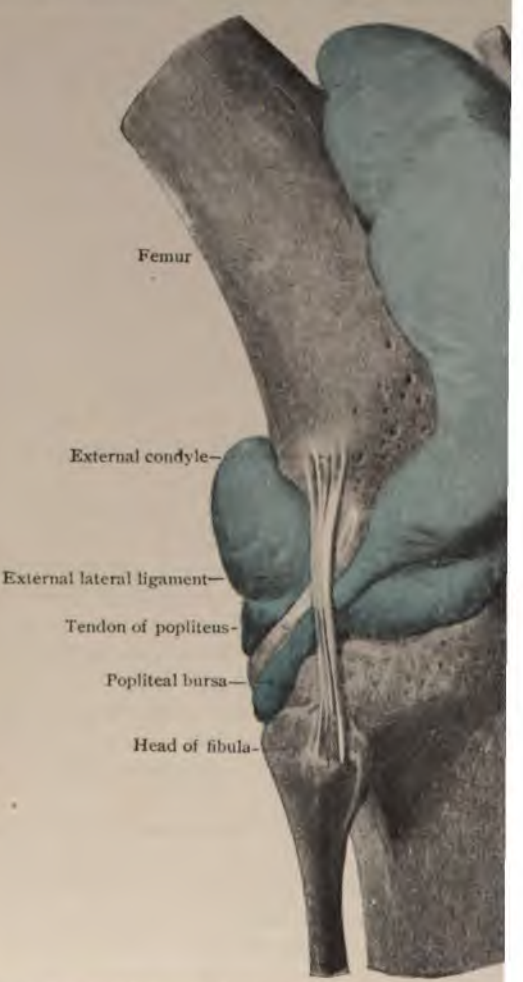

FIG. 488.—Bursæ in region of knee-joint distended with injecti

ing usually at the inner side of the poplit
mass may pulsate on full extension of the l
opening any popliteal sac, caution should
opening into the artery may exist.

Posteriorly the bursa beneath the inn
does not connect with the joint until late a
between the popliteus tendon and the later

Other bursæ in the neighborhood of the joint are posterior under the hamstring tendons and beneath the attachment of the lateral ligaments to the condyles. As any of these may communicate with the knee-joint their possible infection should not be overlooked either in diagnosis or in treatment.

Synovial Cysts.—Synovial cysts arising in connection with the biceps, hamstrings and heads of the gastrocnemius are sometimes found. These cysts may be independent of the joint at first or they may connect with it by a narrow channel. The cysts, if extra-articular, rarely suppurate but may become infected in tuberculosis of the joint.

SENSITIVE KNEE; HYSTERICAL OR FUNCTIONAL KNEE; NEUROMIMESIS.

The term HYSTERICAL knee is a misnomer, since although many of these cases are extremely nervous and hypersensitive, the name hysterical is apt to indicate a certain amount of deceitfulness. While this element may be present, yet in the large majority of cases EXAGGERATION of symptoms would be the more correct term.

Any injured knee, with subsequent effusion and fibrous adhesions after a long enforced rest, will be painful when motion is again attempted; but while rest is the treatment indicated for the acute inflammatory stage, it must be remembered that motion is the normal condition of a joint. Accurate discrimination is often necessary to decide as to the time when rest should be discontinued and motion instituted. With such an injured articulation, PASSIVE HYPEREMIA and TENDERNESS will continue indefinitely unless normal joint action is restored. The patient also has been nursed and has been idle and upon crutches for months, until a condition of invalidism, a morbid craving for sympathy and an exaggerated idea of the suffering have been developed (Traumatic Neuroses, p. 657). The patient will scream or cry when the slightest attempt at motion of the knee is made, but if the attention is distracted the joint can be freely handled. Comparison with the opposite knee will show but little flexion even after months, and edema rather than induration will be present, with only moderate puffiness above and below the sides of the patella. In fact, there will be the absence of all signs that would indicate after such a length of time, either tuberculous or other degeneration of the joint (Fig. 480). The symptoms as described by the patient will be out of all proportion to the actual conditions. Muscle spasm will be voluntary and the atrophy will be only that of disuse.

Fig. 480.—Sensitive knees after a year of house showing no flexion or deformity or induration and with very slight effusion in joint.

Of course it is essential before commencing treatment that tuberculous disease be carefully excluded, or irreparable damage will be done by the surgeon. For this purpose, the X-ray will render valuable assistance.

Treatment.—All causes of ill health must
hygienic and medicinal course of treatment
encouragement and control by the surgeon i
and determination in the patient must be ar
pain. Removal from home surroundings is u

Gentle but positive movements under
persistent use of voluntary and involuntary r
ful, and training under a proper and hopeful
orthopaedic gymnasium will save such an
hysterical life of invalidism. Several anesth
the patient being encouraged to voluntarily us

FIG. 490.—Injury of femoral epiphysis, resulting in knock-knee.

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[1] Willard, article on Neuromimesis, Warren-Gou

DISPLACEMENT OF SEMILUNAR CARTILAGE OR MENISCUS.

English writers have a peculiar designation "internal derangement of the knee-joint" (Hey), a term that is capable of quite wide application. As ordinarily used it applies to displacement of a semilunar cartilage. The term might properly be applied to any injury within the joint, as fracture with fragment projecting into the articulation, loose bodies, slipping or fracture of cartilage, detachment of ligamentum alaris, papillary synovitis, etc.

This accident is produced by sudden and extreme forcible bending of the knee and especially by outward twists as in football, tennis and other athletic sports. The pain is extreme, the limb is fixed in the position of flexion and the cartilage can sometimes be felt as a hard body beneath the skin. The entire cartilage is sometimes torn off from the tibia, but more frequently a portion, especially that covering the internal condyle, is broken off and displaced. If the patient is permitted to use the limb before the cartilage has re-attached itself, recurrence of the accident is to be expected from traumatisms, from eversions or from flexions, with increasing disability and tenderness over the condyle. If the torn or broken or displaced cartilage is replaced before the injury is seen by the surgeon, and swelling has occurred, it is difficult to diagnose the injury from that of a LOOSE BODY. A loose body is usually smaller and the patient has often voluntarily replaced it before the surgeon arrives. Loose body dislocations and ligamentous tears and strains are more common than semilunar displacements. The accident is followed by a violent synovitis with effusion. After repeated displacements the joint may be seriously injured from the chronic synovial effusions and adhesions. The inflammatory deposit about the displaced cartilage is sometimes distinguishable by the X-ray, which deposit prevents full extension of the knee.

The anatomical construction of the knee-joint is sufficient to explain the greater liability of the internal ligament and of the internal semilunar cartilage to injury, especially in the flexed position of the joint.

If tenderness exists at the inner condyle or over a discoverable prominence it may be inferred that the semilunar cartilage rather than a loose body is at fault. Sprains, fractures and contusions give different symptoms.

Diagnosis.—LOOSE BODIES in the joint do not fully lock the knee and the painful point changes with the position of the offending mass.

THICKENED SYNOVIAL FRINGES, AND FIBROUS FATTY BODIES give rise to pain from being pinched between the bones. The locking is not as sudden nor as complete as when the cartilages are displaced and the pain is not as distinctly localized at the internal condyle. Sometimes the mass can be felt, more frequently it disappears before the surgeon is called.

Treatment.—Under anesthesia the cartilage may be forced back to its position in the popliteal space by pressure of thumb, or by a hard object as the edge of a table, combined with forcible flexion of the limb, and followed by traction and rapid extension with rotation. Noble Smith[1] advises placing the thigh of the patient across the surgeon's thigh during manipulation of replacement, as this position secures a certain amount of

[1] Lancet, June 13, 1891.

added traction from the weight of the flexed leg. Efforts must not cease until the leg can be brought to NORMAL EXTENSION on the thigh, lest disability or recurrence takes place.[1] Inflammatory symptoms will usually supervene which will require rest for six weeks in gypsum bandage in the hope of securing adhesion of the cartilage to the tibia. Fixation in full extension with confinement in bed until effusion has disappeared, will save many years of discomfort and pain. The plaster splint and crutches must afterwards be used for two months with the limb in the extended position until the cartilage is anchored in position and the lateral ligament healed. Adhesive plaster strips encircling four-fifths of the knee in front will permit limited motion, which with massage and active and passive muscular exercises prevent ankylosis. The application of splint or apparatus controlling rotation and lateral strain, together with stop-joint limiting flexion, will prove beneficial (Fig. 491).

FIG. 491.—Knee-splint for dislocation of the semilunar cartilage. Detachable ankle joint. (Lentz.)

Jones[2] recommends as after treatment, that the patient be educated to walk in-toed or PIGEON-TOED to prevent strain in the internal lateral ligament; and also the raising of the inner half of the shoe at heel and ball, in order to throw the weight upon the outer side of the foot and on the outer knee ligament.

Operative Treatment.—In persistent cases of recurrence, the cartilage is cut down upon and removed under strict aseptic precautions, the joint having been previously injected with 2 per cent. formalin in sterile glycerine. Removal of the meniscus is better than attempting to anchor it in position, as the latter plan is likely to fail. Removal as a rule does not interfere with final good joint motion.[3]

Before entering a knee-joint to remove a semilunar cartilage or loose body the surgeon must exercise even more aseptic precautions than in a celiotomy. He must be absolutely sure not only of his own cleanliness, but of that of nurse, patient and dressings. Sterile instruments only should enter the joint, and if the finger becomes necessary, the rubber gloves must be thoroughly sterile. By the use of the Esmarch bandage or by pinching each oozing point with a hemostat, or by using adrenalin, blood must be prevented from entering the joint. The capsule should be sutured with sterile catgut, the wound closed, and plaster-of-Paris fixation enforced for ten days, after which the patient may walk about on the cast and with crutches if no inflamma-

[1] Mayo Robson, Brit. Med. Jour., 1902.
[2] Lond. Clin. Jour., May 9, 1906.
[3] H. Ling Taylor, Orth. Surg., 334.

tory symptoms result. Later if the usual means of massage and prolonged exercises are employed to restore joint and muscular mobility an excellent joint will be secured (Chronic Synovitis, p. 530).

Prognosis.—The results of operation are usually favorable and good motion is to be expected. Failure will occur if any fragments of cartilage remain or if fibrous masses subsequently form.

The CRUCIAL and ALARIAL LIGAMENTS are seldom torn except in severe injuries accompanied by fracture or dislocation.

When such a lesion is complete, long fixation of the limb will give time for repair, but weakness and uncertainty of control usually remain. Exploration of the joint and stitching of the torn ligaments by catgut suturing is not very satisfactory.

LOOSE OR FLOATING BODIES.

Synonyms: Lipoma arborescens; hypertrophy of synovial villi.

Small bodies known as MELON SEEDS or RICE BODIES may be of traumatic, degenerative, osteochondritic or of tuberculous origin. Occasionally these bodies are of large size. They consist of fibrous material, fatty tissue, cartilage or bone. They are formed by the separation of villous growths from the fringes of the synovial membrane or by fibrinoplastic development from tuberculous infection. Fatty growths from the thickened fringes may become separated or remain attached by pedicles.

During the violent activities of adolescents these fibrous or cartilaginous pieces become displaced. They usually develop from embryonic cartilage cells in the synovial fringes, becoming detached by slight traumatism. Usually they are not discovered until such time as one or more of them slip between the joint surfaces, when after some violent flexion of the knee, agonizing, sickening pain seizes the patient and the limb is fixed in the flexed position. The offending body can sometimes be located with the finger, but more frequently after a little manipulation it slips back to its former position and the limb can be at once extended. The Germans call these bodies "joint mice," a very appropriate name as they often hide themselves for weeks or months and frequent investigations may be necessary to locate them. Tenderness, synovitis and effusion are likely to follow displacement, and if often repeated, disability and lameness will be permanent. Sometimes months will elapse before some particular motion of the joint will reproduce the displacement.

Treatment. - Immediate replacement can usually be effected by manipulation, forcible flexion and extension. Complete rest followed by adhesive plaster strapping of the joint and care in use will prevent further accident; or a gypsum cast and crutches will be necessary. Should the displacement become frequent and chronic synovitis result, the body must be distinctly located, and if giving pain should be cut down upon and removed. If the patient has discovered that certain motions will cause the body to become palpable, it is wise to use local anesthesia (p. 21) in order to secure the benefit of the patient's voluntary movements, since it not infrequently happens that the offending body will disappear during complete anesthesia and the surgeon will be foiled in his attempts to remove

it. Fixing the object with a needle before operation is recommended but it is difficult to accomplish. A better plan if possible is to grasp it through the skin with a double tenaculum. It should be remembered that several hundreds of these bodies may be present if they are "rice bodies," or there may be one or more as large as an almond kernel. When small and multiple, thorough opening of the joint and washing with sterile salt solution will be essential.

Under strict aseptic precautions and painting the skin with iodine, an incision is made directly over the discovered body, which can sometimes then be extruded by direct pressure. In searching for other masses the bare finger should never be inserted into the joint but a thoroughly sterile rubber glove should be worn and forceps used. The capsule should be stitched with silk or fine chromicized gut, the skin closed without drainage. All hemorrhage should be controlled before closure of the capsule, as hemorrhage within the joint would necessitate reopening. The joint is placed at rest in gypsum for a week, after which time voluntary motion should be permitted. Increasing passive motion with the use of crutches is employed for another week, after which locomotion may be attempted and gymnastic exercises instituted.

Hypertrophied Synovial Fringes.—Hyperplastic or hypertrophied fringes of the synovial membrane may follow any inflammatory condition of the joint resulting from frequent slight traumatisms with effusion. Any of these masses, or the masses of coagulated fibrin found in chronic effusions in the joint, may become pinched or caught in the movements of the knee, giving pain, discomfort, disability and subsequent inflammatory symptoms similar to other loose bodies.

Treatment.—An incision on either side of the patella is necessary to thoroughly explore the joint and remove the offending bodies. The fringes should be trimmed off, the capsule closed with fine chromicized gut and the skin and subcutaneous tissues sutured. Gypsum fixation for a week is to be followed by voluntary and involuntary movements; then crutches for three weeks and muscular exercises continued until motion is complete. The subsequent result will depend largely upon the original cause of trouble, but marked benefit is to be expected. In tuberculous disease a microscopical or laboratory examination or tuberculin test (p. 375) will assist in diagnosis. Exploratory operations are often justifiable for diagnosis.[1]

JOINT HEMORRHAGE.

A violent contusion or laceration of a knee without any external wound may be followed by a large effusion of blood. If this takes place slowly it is not painful. Ice and a firm splint should be at once applied, and complete rest enforced. If the diagnosis is established by the symptoms and X-ray, the joint should be injected with a 2 per cent. solution of formalin in sterile glycerine. On the third day it may be opened and all fluid and clots thoroughly washed under most careful asepsis, forceps or a clean gloved finger being inserted to remove clots. If hemorrhage has entirely ceased, the wound may be closed at once. If there is still oozing, gauze drainage

[1] Tr. Amer. Orth. Assoc., 1900, 25.

should be maintained for two or three days, the stitches inserted at the time of operation being tied loosely. In cases of defective nutrition there is danger of the clot becoming infected. Later, manual massage and voluntary and gymnastic movements must be employed.

HEMOPHILIA.

Hemophilic and purpuric knees in "bleeders" should be cautiously treated if previous hemorrhages have occurred, since operation may be fatal. These cases may simulate mild tuberculous infection but the Röntgenogram will show the absence of bone disease in hemophilia.

Thyroid extract in five grain doses injected hypodermically has been of service; adrenalin and gelatin have also been employed. Formalin 2 per cent. in sterile glycerine should be injected before joint operation if a hemophilic tendency is known, and oil of erigeron canadensis given persistently (Hemophilia, p. 326).

The author recalls a case of simple arthrotomy of the knee in which constant subsequent oozing of blood occurred in spite of all operative, mechanical and medicinal measures, the child dying in five days. Later inquiry developed the existence of a hemorrhagic tendency in the family.

RUPTURE OF QUADRICEPS AND OF TENDO-PATELLÆ.

Violent muscular contraction of the quadriceps may tear the muscle above or the tendon below the patella or may tear off the tibial tubercle, instead of producing a fracture of the knee-cap. If the swelling and hemorrhage are not too great, a transverse furrow or gap will be felt either above or below the patella or in the belly of the quadriceps and there will be marked inability to extend the leg. When the tendon is ruptured below the knee-cap, the patella will be drawn upward by the extensors.

Treatment.—If the quadriceps and vasti are torn across, the retracted ends should be cut down upon (after injection of the area with formalin), and sutured to the lower raw surface above the patella by chromicized gut or celluloid thread or kangaroo tendon. The thigh is flexed upon the pelvis to relax the muscle. If the tear is below the knee-cap, the same suturing operation is done. A separated tibial tubercle is anchored to the periosteum. The knee is fixed in a plaster cast for four weeks and the limb elevated. Walking with the aid of crutches and gentle passive movements, with massage and muscular gymnastics, will help to restore motion.

CLICKING, SNAPPING, OR TRIGGER KNEE.

This subluxation is due to relaxation of ligaments and sliding of the tibia upon the femur by sudden voluntary muscular contraction or by hyperextension.

When the annoyance is positive, forcible replacement followed by temporary support and massage and gymnastic muscular movements, will be sufficient in children without the application of an apparatus, but adults will usually require support. Side movements of the patella or of the semilunar cartilage or of the biceps tendon may give a similar sound.

CREAKING KNEE, often very annoying to the patient from the audible noise especially in going up and down stairs, is rarely found in children, except in arthritis deformans. In elderly, fat people it is a cause of much pain and disability in walking and will require a supporting brace (Fig. 491, p. 540).

It is usually attributed to a deficiency of the synovial fluid but is rather due to osteo-arthritic, gouty or rheumatoid deposits, or to relaxation of muscles and ligaments, with edematous and relaxed synovial membrane. The synovial fringes may be pinched by rubbing together until thickening occurs, resulting in separation of the masses, which finally become loose bodies.

TRIGGER KNEE is the result of loose bodies in the joint or of relaxed ligaments and muscles.

ABSENT OR DEFICIENT OR RUDIMENTARY PATELLA.

Partial or entire lack of development of the patella may occur in connection with other congenital deformities at the knee[1] (Fig. 693, p. 744).

Early and long-continued massage of the quadriceps will increase its strength, and if difficulty in walking occurs a supporting steel apparatus may be required.

DISLOCATION OF THE PATELLA OR SLIPPING PATELLA.

The knee-cap may be congenitally displaced, or the deviation may be produced by traumatism or knock-knee or quadriceps relaxation or paralysis or by violent contraction. The outward dislocation is the more common variety, but in traumatisms the bone may slip in any direction or be turned upon its edge or even reversed a half circle. Acute synovitis is likely to follow unless rest is enforced. Repetitions of the displacement will occur in lax conditions and will produce a chronic synovitis.

Treatment.—Replacement can usually be accomplished without ether if the knee is hyperextended and the thigh flexed. Retention by laced or elastic knee-cap or steel spring with lateral pads is helpful. If continued displacements occur the tibial tubercle with the attached tendo-patellæ may be detached and anchored by mattress sutures of kangaroo tendon, chromic gut or celluloid thread nearer the median line of the body, to bring it in better line with the thigh. The capsule on the inner side of the patella may be plicated, or the tendo-patellæ may be split longitudinally and one-half of it stitched to the periosteum and sartorius expansion. A relaxed and elongated quadriceps can be pleated and shortened at the same time.

As the knee resents operative interference even more than the peritoneum, extreme aseptic precautions must be taken by the surgeon in every portion of the technic. If the surgeon is absolutely clean in all his work, however, he need not fear to invade this cavity.

In-knee should be corrected by supracondyloid OSTEOTOMY of the femur (p. 296).

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[1] Little, Lancet, Sept. 15, 1897.

BACK-KNEE; ELONGATED OR RELAXED PATELLAR TENDON.

Congenital back-knee is considered on page 744.

Acquired genu recurvatum or retrorsum (Fig. 492) is the result of paralysis (p. 614) or of equinus club-foot, or of joint disease. In the first-named conditions the posterior ligaments are stretched; in the latter they are destroyed, usually by tuberculous disease.

Treatment.—In deformity acquired from the effort in equinus to bring the heel to the ground, the tendo Achillis should be divided and an apparatus with stop-joint at the knee used to prevent further deformity, since a change in the shape of the femur and tibia is difficult to remedy. In paralytic acquired back-knee, massage, electricity and muscular development of the quadriceps will increase muscular tone, and an apparatus with stop-joint to prevent back-knee and protect the joint will be useful (Fig. 562, p. 626).

Operative measures will consist in plicating the extensor cruris or transplantation of the hamstring muscles to the quadriceps (p. 634) or shortening of the tendo-patellæ or quadriceps (p. 544) or arthrodesis in extreme back-knee. In joint disease excision is sometimes desirable if posterior displacement of the tibia has occurred.

FIG. 492.—Paralytic back-knees with acquired talipes varus in left foot, and valgus in right. Lordosis of spine.

CICATRICIAL CONTRACTIONS AT THE KNEE.

Burns or sloughing wounds of the popliteal space will result in severe contractions at the knee-joint. If moderate in degree daily forcible straightening and oil massage of the cicatrix may result favorably if horizontal extension at night is added. A Stromeyer or other posterior extension splint is both painful and inconvenient. Operative measures will include forcible stretching under anesthesia, tenotomy with freeing of the tendons from the scar tissue and dissection of the cicatricial tissue. Turning in of flaps of healthy skin tissue, or the implantation of large skin grafts will frequently be required (Burns, p. 221).

Great care must be taken in the after dressings to keep the knee extended by splints for at least a year. The patient may walk about on a plaster cast with cane or crutches for six months, after which recontraction must be prevented for a year by manipulations and gymnastics with gentle oil massage to prevent keloid.

KNEE, RHEUMATIC.

Although as already discussed (p. 509) rheumatism of the knee is exceedingly improbable in children, yet in adolescents stiffening and ankylosis will often follow a true rheumatic inflammatory attack.

If the diagnosis is assured by the sudden onset, heat, swelling, sweating, uric acid, etc., and cardiac complications, the ordinary antirheumatic remedies, salicylates, etc., should be employed, the kidneys and other excretory organs stimulated, the joint enveloped in cotton or wool or in hot lotions of sodium carbonate, and rest advised. Among the newer remedies aspirin and mesotan are useful (see paediatric treatises).

For the subsequent stiffening, superheated dry air (Fig. 320, p. 364), hot baths, hot and cold douchings, and the therapeutic effect of the high-frequency current or the X-ray are effective. Massage, friction, persistently increasing manipulations, vibratory massage and foot machines to be found in a well-equipped orthopaedic gymnasium, will be helpful (Fig. 152, p. 235). In severe cases, cautious force, under ether, followed by the above active and passive movements, will accomplish much (Ankylosis, p. 533). If contractions have occurred, tenotomies of the hamstring tendons will permit extension, if followed by forcible movements.

Knee, Gouty.—In gouty adolescents, a banquet with plenty of champagne may be followed within twenty-four hours by violent pain in the knee, rapid swelling, heat, effusion; and in debilitated subjects, rapid pus formation with fever and chills.

Flushings of the kidneys and bowels and antigouty remedies should be freely used.

If pus forms, arthrotomy, with washings of iodine, mercuric bichloride or formalin, together with drainage, will become necessary to prevent ankylosis.[1]

Growing Pains.—These pains, so-called, may be due to tuberculous bone or joint disease, to periostitis, osteomyelitis, arterial sclerosis, endocarditis, rheumatism, sacral sprain or sepsis. The child should always be stripped and carefully examined for some positive lesion. Many a child has been crippled for life by the careless diagnosis of growing pains while tuberculous joint disease steadily progressed.

SUMMARY OF THE PRECEDING KNEE CONDITIONS.

1. Apparently slight injuries of the knee often prove more lasting and annoying than those of a more positive nature like fracture or dislocation.

2. Every injury of the knee should receive careful examination, since laceration of ligaments or of periarticular tissues, or displacement of semilunar cartilages or of loose bodies may have occurred. Obscure fractures and epiphyseal separations also are not uncommon. An X-ray and anesthetization will greatly assist in correct diagnosis.

3. Every injured knee requires rest during its acute inflammatory stage; rest in bed, fixed dressings, or crutches. Heat and cold are two powerful agents in aborting a threatened inflammation.

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[1] Willard, Inter. Text-Book of Surgery, Warren-Gould, vol. i, 701.

4. Adhesive plaster strapping is of great value in securing partial restraint of a knee and in producing absorption of effusion. Plaster-of-Paris and other restrictive apparatus must be used with discrimination.

5. Blood-clots in the joints are removed by incision and flushing.

6. Effusions, if large, are removed by aspiration or incision, followed by weak iodine or formalin injections.

7. Displaced semilunar cartilages are stitched in position, or removed. Loose bodies should be removed.

8. Motion is the normal condition of joints, consequently massage and voluntary motions are to be instituted as soon as the inflammatory stage has passed. Neglect of this precaution may result in a neuromimetic patient or a chronic cripple.

9. Sensitive neurotic knees must not be mistaken for diseased ones.

10. Complete rest during the primary inflammatory stage, followed by massage, voluntary and involuntary movements, gymnastic exercises, hot-air treatment, hot and cold douchings, are the best means for preventing ankylosis.

11. Should ankylosis follow, forcible straightening, tenotomy, osteotomy or arthroplasty will be required.

12. Knee tuberculosis will often follow even slight injuries.

CHAPTER XX.

ANKLE AND FOOT INJURIES.

ANKLE AND FOOT TUBERCULOSIS.

TUBERCULOUS infection of ankle (Fig. 493), tarsal bones and foot is met with occasionally in children and differs but little from the same condition in other joints, except for the added dangers of weight-bearing. In feeble children, non-resistant from heredity, environment or disease, rapid destruction of hard and soft tissues may occur. The tibia or the astragalus is usually primarily affected, but the infection spreads readily through the tarsal bones and articulations (Fig. 494).

FIG. 493.—Tuberculous disease of ankle-joint.

FIG. 494.—Extensive tuberculous disease of ankle and tarsus.

The early symptoms of pain, swelling, limp, reflex spasm, induration, and atrophy of calf muscles are often mistaken for non-tuberculous conditions, as sprains, rheumatism, flat-foot, or tarsitis, and the disease is allowed to progress to caries before proper treatment is commenced (Fig. 169, p. 249). A slow invasion with symptoms above enumerated should always lead to the diagnosis of tuberculosis and the X-ray may give valuable aid in locating the foci.

Treatment.—The OPEN-AIR and PROTECTIVE treatment as outlined on p. 380 should commence early and be long continued. Fixation with gypsum cast (Fig. 470, p. 512) and the use of crutches is imperative, as the weight of the body should not be borne on this joint for a year or more. A Thomas knee splint (Fig. 471, p. 513) may be added. Bier's passive hyperemia (p. 388) is readily applied. If protection is neglected until suppuration has taken place, repeated erasions of the ankle and of the tarsal bones in children will prevent the necessity for excision or amputation. Amputation should be reserved for extreme cases and for adults.

ANKLE AND FOOT SPRAINS.

SPRAINS and STRAINS of the ankle are more common than at any other joint of the body. The ligaments and tendons may be stretched or torn, the periosteum of tibia or fibula stripped, or either of the malleoli torn off, or the synovial membrane may be contused. Fracture and epiphyseal separation of tibia or fibula are common and tarsal ligament strains and tarsal fractures also frequently occur in severe traumatisms.

Etherization and an X-ray are advisable in every doubtful diagnosis, since many patients are permanently disabled by so-called "ankle sprains" (Fracture, p. 364).

FIG. 495.—Adhesive plaster straps applied for sprain of ankle.

Repetition of the accident frequently results in a condition of chronic sprain or synovitis, with pain, stiffness and muscular weakness. In non-resistive children tuberculosis of ankle may follow.

Treatment.—In slight injuries, the application FOR AN HOUR of water kept at as high a temperature as can be borne, will often enable the person to walk the following day if ADHESIVE PLASTER straps are applied in an imbricated manner, firmly enclosing the joint, foot and lower leg (Fig. 495). In more severe cases, the application of a plaster-of-Paris cast for several days and the use of crutches will hasten the cure.[1]

If the X-ray shows fracture of a malleolus or tarsal bones, the cast should be continued for two weeks, then temporarily removed (p. 365), gentle massage and passive movements begun and the casing reapplied. These gentle movements are to be repeated daily, with massage, hot-air baking and gymnastic movements until firm union of bone and ligaments is secured. Iodine or iodine petrogen and cataphoresis are also helpful in promoting absorption of inflammatory products.

In lusty athletes, if the X-ray and clinical symptoms reveal no fracture, daily massage and hot-air baking (Fig. 320, p. 364), with hot and cold douchings, and the firm application of a flannel bandage or adhesive strips will give speedy relief. If the hot-air oven is not available, soaking the ankle in very hot soapsuds previous to an oil massage is valuable. Oil is better than alcohol. The foot machines in an orthopaedic gymnasium will be helpful (Fig. 152, p. 235). Tarsitis from injury and wounds are discussed on p. 705.

[1] Dominion Med. Monthly, Sept., 1908.

CHAPTER XXI.

SURGICAL CONDITIONS OF THE SHOULDER.

SHOULDER TUBERCULOSIS.

TUBERCULOSIS of the shoulder joint, although occurring in less than 2 per cent. of the joint diseases, is serious in its results in adolescents.[1] In children it sometimes accompanies tuberculosis of other joints.

The pathology is the same as that of other tuberculous joint diseases (p. 368). (See Frontispiece.)

Symptoms.—After a slight traumatism, pain, aching in character, interference with motion, rigidity which is often masked by the compensatory movements of the scapula, slowly increasing thickening about the joint, atrophy of muscles, then effusion, ankylosis and suppuration are the results. The course in children often runs from two to three years, for the reason that at the period when the disease could have been arrested the patient had been long treated for that refuge of carelessness, rheumatism.

Caries sicca is the slow atrophic form of tuberculous disease of the head of the humerus, a dry osteo-arthritis, steadily degenerating and destroying both bone and synovial membrane and ending in ankylosis, very rarely in suppuration. When the masses of tuberculous granulation are found in the medulla, the condition is known as caries fungosa or carnosa, a form seldom seen in children.

Diagnosis.—A thorough examination can be made only by comparison both in front and behind of the two shoulders bared. Rheumatism, arthritis deformans, bursitis, sprain, periarthritis and the various other conditions discussed on pages 374 and 376 must be carefully differentiated and the distinctive tuberculous symptoms above enumerated regarded. The aid of the Röntgen ray is advisable.

Prognosis.—Recovery with motion is to be expected if treated early. If late, and especially in adolescents, the outlook as to functionation is unfavorable.

Treatment.—A healthful out-door life with rest and protection are of prime importance (p. 380). A sling or bandage or adhesive straps should bind only the hand to the body beneath the clothing, in order that the weight of the arm may tend to separate the joint surfaces. If a tense deltoid continues to give pain, the upper arm may be fixed by gypsum bandage at a right angle to the trunk.

If effusion is discovered, it may be ASPIRATED, the joint irrigated and injected with Lugol's solution of iodine, or 2 per cent. formalin in glycerine. If suppuration occurs, the pus may follow the biceps to the anterior border of the axilla or burrow beneath the deltoid or behind the axilla along the

[1] Townsend, Trans. Amer. Orth. Assoc., vol. vii, p. 137.

subscapularis. In suppurative cases in children, ERASION is the preferable operation, removing only the diseased bone, followed by mopping with carbolic acid and alcohol. In adolescents, excision, if done subperiosteally, may retain motion. Old sinuses are curetted, then injected with pure tincture of iodine, or bismuth (p. 400), then dry cupped. Bier's elastic constriction is not practically helpful. Amputation in adults is occasionally advisable.

SHOULDER INJURIES.

A wrench or twist of the shoulder carrying the humerus beyond its normal mobility will result in a sprain or stretching or rupture of the ligament or of tendons or muscles or of surrounding structures. The pain will usually follow quickly, causing disability. A sprain frequently results from rude dragging of a child by the arm, or from lifting it suddenly. Dislocation may also result from the same cause.

The diagnosis from synovitis, tenosynovitis and bursitis and from tuberculosis is often troublesome.

The constant use of the arms and the great mobility of this joint make injuries of the shoulder common. Pain, swelling and other signs of inflammation will naturally follow traumatism of this joint or its surrounding structures. PERIARTHRITIS will follow either sprain, strain, fracture, dislocation, tear of the ligaments, rupture of the biceps or coracobrachialis or any of the neighboring muscles, as well as contusion of the deltoid, fracture of the acromion or violent wrenching of the joint. BURSITIS, gonorrheal, infectious, or traumatic, beneath the deltoid or the supra- or infraspinatus or coraco-acromial ligament, will give the symptoms of disability, but the pain and tenderness will be localized over the particular bursa involved.

The common situation of BURSITIS is beneath the deltoid or sub-scapular or coracoid. If the effusion is moderate, the tumor will be fluctuating; if large, it will be firm and may simulate benign or malignant tumor. Bursitis above or below the acromion from carrying weights may occur.

Inflammation in the bursæ about the shoulder-joint may be mistaken for tuberculosis or for acromioclavicular arthritis.[1] A careful examination and the exclusion of the ordinary symptoms of tuberculous disease of the shoulder is important. Local tenderness over an inflamed bursa will be present, motion will be restricted on account of pain rather than from muscular rigidity. A localized tumor can sometimes be palpated. Suppuration is more common in inflammatory conditions than in tuberculosis (p. 550).

Effusion in the joint after injury is more rare than at the knee. If the condition is a general periarthritis, much care will be required to properly diagnose the exact injury. The pain may be local or may radiate down the arm, according as pressure upon the nerves is absent or present. A TENOSYNOVITIS of the biceps tendon is not uncommon, in which event tenderness locating itself over this area and a creaking sound may be distinguished on motion. Partial fixation of the joint will occur and the pain, if there is neuritis, will be severe.

[1] Bost. Med. and Surg. Jour., Oct. 29, 1908.

To diagnose any of the above injuries as rheumatism, without a careful examination as to the actual cause, is most unwise. A special cause can nearly always be found if the two bared shoulders are compared.

Exostoses are rarely met with. If benign and painless and in such situation as not to interfere with shoulder movements, they need not be removed (Fig. 533, p. 603).

Treatment.—During the acute stage and while there are inflammatory conditions, rest in a sling or with a bandage is required, with local heat, dry or wet. The arm should be placed in the position of greatest comfort and a binder's board or leather shoulder cap fastened in position, or the shoulder may be fixed with adhesive plaster or plaster-of-Paris. When the acute symptoms have subsided, massage and passive and active movements should be commenced or electricity may be applied. The movements are to be limited to a point where resultant pain only lasts for a short time. If permanent stiffening occurs, careful manipulations under an anesthetic followed by persistent movements are most helpful.

If suppuration occurs, the abscess should be opened, mopped with carbolic acid or with iodine, and drained.

Rest by fixation with a plaster cast in the abducted position is sometimes the most comfortable position. In young children, the arm may be laid upon a pillow at night with arm at right angles with the body.

In chronic or subacute cases the adhesions should be broken up under ether. Subsequent massage and gymnastic muscular movements are essential.

RUPTURE OF BICEPS TENDON OR MUSCLE.

Rupture of the long head of the biceps or dislocation from its canal in the anterior part of the capsule of the shoulder is the result of accident or strain. The pain is usually sudden and severe; at times an audible snap is heard followed by pain and disability and flexion of the forearm. The actual separation of the ends of the tendons can sometimes be discovered. The local tenderness is great, and on the following day the hardening of the tissues prevents satisfactory examination except under anesthesia. The muscular fibres rarely give way unless the muscle is degenerated.

Treatment.—If the diagnosis is established, the best treatment is to cut down upon the ruptured ends of the tendon or muscle and unite them with chromicized gut or silk. If the tendon is dislocated it may be sutured in its groove and a fascial bridge stitched across it. The arm should be dressed with forearm in the flexed position and complete rest maintained for three weeks, followed first by gentle passive and active movements, later by more vigorous ones. Massage and electricity will be helpful.

ANKYLOSIS FOLLOWING INJURIES, FRACTURE OR DISLOCATION.

In dislocation or fracture, the head of the bone may be driven so violently against the axillary nerves that severe neuritis ensues, with subsequent inflammatory deposits in and about the joint, often resulting in fibrous or even bony ankylosis (Fig. 496). An examination of the bared back

will show that the scapula moves with the humerus in all directions. In neuritis the pain over the course of the nerve and down the arm, together with numbness and tingling, will be most severe. The disability is often so great that the arm becomes useless.

Treatment.—After the primary reduction of a dislocation or a fracture (p. 339), rest is important, but it must not be continued beyond the stage of inflammatory symptoms unless neuritis is positive. Unfortunately, while neuritis requires rest, the prevention of ankylosis necessitates motion of the joint, and wise discrimination is necessary. When the neuritis subsides, gentle massage, hot-air baking (p. 364) and regulated movements in a properly equipped gymnasium will assist in restoring motion (p. 271). Moderate, cautious, forcible movements under ether are helpful, but the scapula is so freely movable that great compensation of movement is ultimately secured even if the shoulder-joint becomes permanently fixed. ARTHROPLASTY is seldom if ever desirable.

FIG. 496.—Ankylosis of shoulder-joint following injury.

Shoulder Neuritis.—A blow upon the shoulder or upper arm or circumflex or deltoid may be followed by a painful neuritis that will disable the patient for a long time. Constitutional causes may also lead to the same condition (Neuritis, p. 659).

Certain movements, especially involuntary abductions, are very painful. The pain may be a dull ache or a severe pain and is often tingling, not always following the line of a nerve.

Treatment.—Rest in sling and splint with the administration of acetanilid and codeia, will greatly relieve the neuritic pain. Local applications of chloral and camphor, equal parts, or of menthol, or oil of peppermint or iodine or iodine petrogen are palliative.

SHOULDER, HABITUAL OR RECURRENT DISLOCATION.

Congenital malformation of the glenoid or of the head of the humerus is rare, but may permit habitual dislocation.

Habitual luxation from relaxed ligaments in infantile spinal paralysis and in birth palsy is not uncommon. From paralysis early in life, the ligaments of the shoulder-joint may become so stretched from the weight of the flail arm that a finger can be inserted between the acromion and the head of the humerus. The same result is occasionally seen after traumatisms or extensive destruction of the bone or in syringomyelia. Following a traumatic dislocation a recurrence occasionally takes place after moderate

muscular exertion, as throwing a ball. The depth of the glenoid cavity is sometimes reduced by fracture of the rim, or the capsule may be widely torn, together with the infra- and supraspinatus muscles. If the position of the head is uncertain, an X-ray skiagram will settle the question.

Treatment.—As a rule but little difficulty is experienced in reduction but retention is troublesome. Muscular tone must be developed by massage, electricity and moderated voluntary and involuntary movements. Elevation and abduction of the arm should be prohibited. An effective apparatus is a leather or canvas cap covering the top of the shoulder and the upper fifth of the humerus. To prevent the movements most likely to produce the luxation, the upper part of the cap is laced or buckled by straps across the chest and the lower portion laced about the arm. A steel-jointed outer plate may be added, if greater support is needed.

OPERATIVE TREATMENT.—CAPSULORRHAPHY.—Should the recurrence of dislocation be frequent, operative interference is needed. For outward or posterior luxation an incision is made downward from the acromion over the deltoid, the fibres of which are to be separated, not divided. The circumflex nerve should be avoided. The joint also can be reached by lifting the deltoid from its insertion. The capsule is opened, the bone replaced and a sufficient section of the capsule removed. The opening is closed by fine chromicized catgut or silk or a purse-string suture may be used. Subsequent massage and electricity are necessary.

When the dislocation is downward or forward the capsule may be reached by an axillary incision from the coracoid process downward to the tendon of the pectoralis major, avoiding the cephalic vein.[1] The dissection is carefully carried down to the bone by separating the deltoid from the pectoralis major until the coracobrachialis is reached. The insertion of the pectoralis major is then sectioned as far as necessary and the subscapularis divided, being reached by rotating the humerus outward. An oval section of the capsule may be removed, or the capsule folded or narrowed by a purse-string suture. The opening in the capsule is stitched with chromicized catgut and the wound closed without drainage, or the capsule may be puckered and stitched without opening the joint.[2] The transplantation of a portion of the trapezius to the greater tuberosity of the humerus will also assist in drawing the head of the bone backward in cases of repeated forward dislocation.

When the long head of the biceps has been torn from its groove, it plays over the glenoid cavity and prevents reduction. In these cases the tendon should be sutured in position; the subscapularis divided and the coracobrachialis separated from the axillary vessels and nerves, which should be saved. The capsule may be opened, the joint examined for mechanical causes of trouble and the capsule reefed, excised or overlapped.[3]

The biceps tendon can be replaced in its groove and retained by a bridge flap of periosteum or fascia. If fibrous tissue fills the glenoid it should

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[1] Willard, Jour. Amer. Med. Assoc., July 23, 1904, 139; Trans. Surg. Section Amer. Med. Assoc., 1904.

[2] Willy Meyer, N. Y. Surg. Society, Feb., 1908.

[3] Thomas, Amer. Jour. Med. Sci., Feb. and Mar., 1909; Univ. of Penna. Med. Bull., Mar., 1909.

be scooped out and the head of the humerus retained in the glenoid by catgut or silk suturing of fascia, muscles and capsule.[1] In obstinate cases the supra- and infraspinatus, teres and subscapularis may require division.[2]

The wound is dressed without drainage and the deltoid relaxed by fixing the arm in abduction with gypsum. Active movements should be commenced in a gymnasium in the third week and continued for months. In case of failure, arthrodesis or excision of the humeral head is advisable.[3]

SHOULDER, UNREDUCED DISLOCATION.

A dislocation of the shoulder is sometimes overlooked by the surgeon after an accident when the swelling and pain are great. In severe injury near a joint it is often impossible to make a proper diagnosis without an

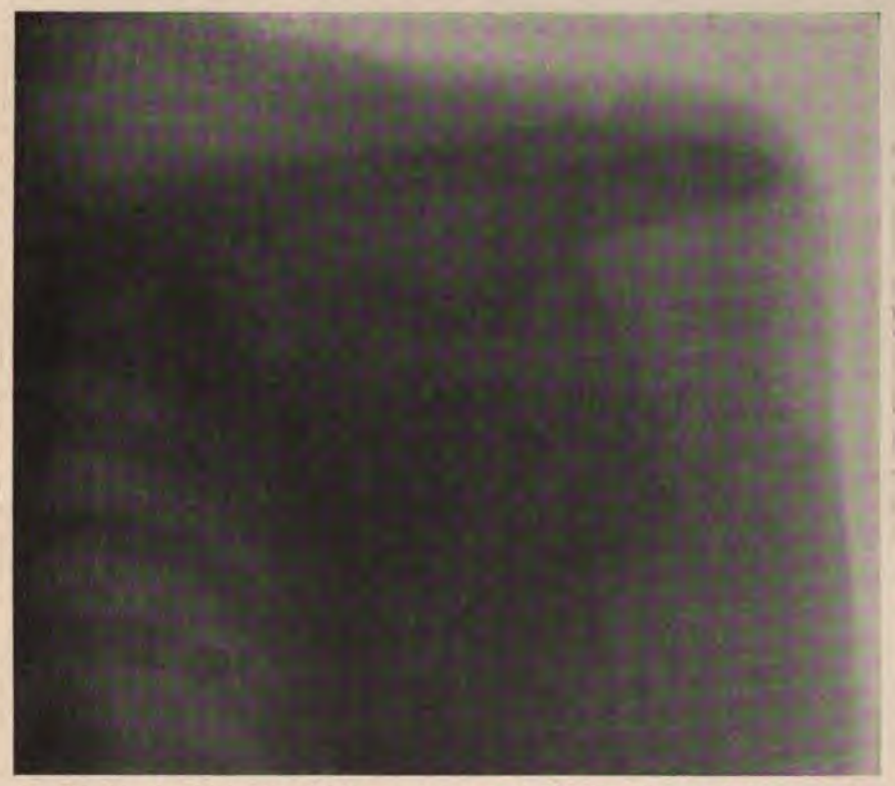

FIG. 497.—Unreduced dislocation of the humerus of six months' duration. Replaced by open operation.

anesthetic and without the use of the X-ray. Fractures, luxations, epiphyseal separations and other serious injuries are often diagnosed as sprains or contusions. Luxations even when neglected for a long time should not

[1] Sheldon, Ann. of Surg., xlvi, 1907, 623; Jonas, Ann. Surg., li, 890.
[2] Burrell, Amer. Jour. Med. Sci., Aug., 1897.
[3] Souchon, Trans. Amer. Surg. Assoc., xv, 311.

be looked upon as irreducible, since skilful tr in replacing the head of the humerus.

The position of the head forward, downw accurately located by the clinical symptoms a (subspinous), the hard round head is easily fe or subclavicular), or downward, into the axilla a vacancy will exist beneath the acromion (Fi

The pressure upon axillary nerves will re tingling in character, or in neuralgia or neuritis of the joint. Fracture of the humerus, glenoid separation

FIG. 498.—Lines of incision for operations at the shoulder-joint.

Treatm

culties of great as i displaced h never to r replacemer neglected deposit ab ordinary m ods shoul several we nipulative necessary joint. In deformity epiphyseal be require front or b tion of th ting band of the ca head rep capsular with chro tion.[2] Pr cles or t usually can be pushed aside unless marked taken place. Passive and active movements by massage and gymnastic exercises (p. 235)

Failure in cases where pain is severe wil of the head through a deltoid or an axillary i

The fibres of the deltoid are separated, is avoided, entrance to the joint may be and pectoralis major. A gimlet or corksc bone for traction, but claw forceps (Fig. 16

[1] For list of accidents, see Willard, Rupture of Phil. Med. Times, Aug., 1873.

[2] Willard, Old Unreduced Dislocations, Jour. An

elevator (Fig. 162) are better. The arm after reduction is dressed in abduction by a plaster splint, or by a padded wooden triangle with its apex in the axilla.

SHOULDER, INFECTIOUS ARTHRITIS.

Septic and pneumococcic infection of the shoulder will give rise to much pain upon pressure, interfering with sleep and motion, and will be followed by great stiffening of the articulation and long-continued tenderness. If the resistive power is feeble, suppuration may follow. Gonococcic infection is occasionally met with in children, even in innocent girls (Gonorrheal Arthritis, p. 582).

Treatment.—Unfortunately these cases as a rule do not come under the care of the surgeon until the joint is partially or largely destroyed, weeks having been wasted in useless treatment for rheumatism. If seen and diagnosed early, absolute and complete rest by splints or bandages is essential. Neither rest nor ice bags can kill the micro-organisms but they may assist the cell elements in their resistance to the infection.

Pneumococcic infection is likely to be followed by partial ankylosis, which will require many months of massage, voluntary and involuntary movements, before normal movements are regained, as the deposit is not only within but also without the joint. (For treatment of suppurative conditions see Infectious Arthritis, p. 580.)

SHOULDER, RHEUMATIC.

Rheumatism of the shoulder is a term applied by careless diagnosticians to a half dozen or more pathological conditions in no wise related to rheumatism. This lack of correct diagnosis and the subsequent faulty treatment result in irreparable damage to the joint. True rheumatic inflammation of this joint is extremely rare in children. The only similarity of symptoms are pain and disability. In a large majority of cases, tuberculosis, osteomyelitis, bursitis, neuritis or inflammation of some of the periarticular structures will be discovered if the part is bared and compared with the opposite shoulder. If the case is truly rheumatic and acute, there will be the normal symptoms of rheumatism, swelling, heat, sweating, concentrated urine, and other signs of lithemia. In chronic or subacute cases, a slow fibrositis with tenderness will be present. In muscular rheumatism outside the joint, the cause is usually from a draught of cold air or wetting, or strain.

Treatment. For muscular pains, hot solutions of sodium carbonate, or dry hot air or wool covered with waxed paper or oiled silk should be applied. Appropriate doses of salol or aspirin or acetanilid will relieve pain. Oil of peppermint or of wintergreen or mesotan or chloral and camphor locally are helpful. Massage, hot air baking (Fig. 320, p. 364), and passive manipulations in more chronic cases will increase nutrition and promote absorption. Electricity, the high-frequency current and X-ray therapy will relieve pain and restore motion. If stiffening and ankylosis take place, the treatment indicated on p. 553 should be employed.

CLAVICULAR AND SCAPULAR DEFORMITIES.

In cases of long ligaments and relaxed muscles with subluxation of other joints, the sternal end of the clavicle, rather than the acromial end, may be more or less displaced. If serious inconvenience results at the acromial end, the articulation may be cut down upon and the bones wired with mattress sutures. At the sternal end a similar wiring operation is sometimes necessary; or the bone may be held in place by osteoplastic flaps chiselled from clavicle and sternum and turned over in front of the joint and there sutured. The slight projection of the head of the clavicle at the sternum, which is especially distasteful to young ladies with low neck dresses, can be improved only by increasing the nutrition of the individual and by gymnastic exercises to develop the clavicular portion of the pectoralis major. A slight benefit may be obtained by a pad connected to a spring passing over the shoulder and attached to a stiff corset.

In working adolescents, a strong leather strap passing over the shoulder and around the chest with pad over the head of the bone will give partial support. The opposite hand should be educated to suit the occupation.

CONGENITAL DEFECTS of the clavicle consist of complete absence or of defect in control of the extremities of the bone, causing subluxation. By permitting the forward falling of the acromion, LOW SHOULDER is produced.

The condition is readily diagnosed by palpation and the X-ray.

LOW SHOULDER.

Low shoulder is often an accompaniment of lateral curvature and is ordinarily caused by marked rotation of the scapula upon its long axis so that this axis is crosswise to the body. A careful examination of the back and of its curves, from the hips to the head, is all-important.

Treatment.—Treatment will consist in attention to the bony and muscular conditions discovered (Lateral Curvature, p. 271).

CONGENITAL ELEVATION OF SHOULDER OR SCAPULA; HIGH SHOULDER OR SPRENGEL'S DEFORMITY.

The scapula may be elevated by a bony bridge extending from the shoulder-blade to the vertebral spinous process, thus acting as a fixed pivot. The restriction of motion, the permanent high shoulder and a radiogra will determine the diagnosis (Fig. 499).[1] Lateral curvature of the spine is coexistent. The condition should not be confounded with high lateral curvature with distortion of the upper ribs. In the latter case the scapula is rotated upon its long axis and the point of the acromion is brought lower than its opposite fellow, while the shoulder-blade itself is mobile.

Treatment.—When the skiagram reveals a bridge of bone, it should be excised,[2] followed as speedily as possible by active movements. If muscles are contracted, they may be divided. If trapezius and serratus magnus are atrophied from non-use, the scapula may become too movable after operation.

[1] Amer. Jour. Orth. Assoc., Nov., 1908, 260–312.

[2] Wilson, Annals of Surgery, xxxi, 468; Rugh, ib. xxxi, 506.

Goldthwait and Painter[1] report an operation in which an incision six inches long was made from the middle of the top of the scapula to the lower angle. The trapezius was separated from the spine of the scapula, the rhomboids, levator anguli scapulæ and the confining portions of the serratus magnus were divided. The trapezius was reattached higher up on the spine of the scapula, and with active and passive exercises good functional results were secured.

[illegible]

SCAPULAR DEFORMITIES

DIMINUTIVE SCAPULA is occasionally met with, especially in cases of congenital paralysis affecting the brachial plexus—birth palsy (Fig. 587, p. 652). It is usually accompanied by marked diminution in size and feebleness of the entire upper extremity. Hemiplegic deformity can sometimes

[1] Trans. Amer. Orth. Assn. 1901, p. 302.

be benefited by tenoplasty or by nerve transplantation (p. 630). The subsequent use of the member will assist in development.

Projection of the scapula on one side with depression on the other is seen most markedly in the rotation of lateral curvature of the spine, with the consequent changes in the two sides of the thorax (Scoliosis, p. 258). The sunken scapula is often rotated on its long axis.

The scapula may become permanently deformed from bony attachment to the spine (Fig. 500).

DISLOCATION OF THE LATISSIMUS DORSI AT THE SCAPULAR ANGLE—WINGED SCAPULA.

The latissimus dorsi may be slipped from its groove over the inferior angle of the scapula by violent muscular action or by accident. This injury permits the scapular angle to tilt outward, producing the "angel wings" deformity (scapulæ alatæ). This tilting of the scapula may take place from muscular debility alone

FIG. 500.—Deformity of scapula from bony attachment to spine.

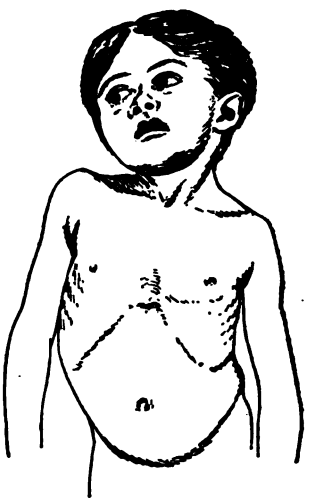

FIG. 501.—Lateral curvature and shoulder elevation produced by cervical rib and scapular attachment to vertebræ.

or from lateral curvature, in which case massage, electricity, muscular exercises and general treatment are indicated (p. 271).

PARALYSIS OF THE SERRATUS MAGNUS with unopposed contraction of the trapezius, levator anguli scapulæ, pectoralis minor and rhomboid will produce the same deformity.

Treatment.—If disabling, the latissimus dorsi is replaced and sutured to the periosteum with chromicized gut, silk or celluloid thread, additional strength being given by turning across the tendon a flap from the neighboring fascia.

CERVICAL RIBS.

SUPERNUMERARY RIBS may spring from the cervical or other vertebræ. In the neck they may compel abnormal routes of the subclavian artery or other structures and give pain. They may also produce distortion of the neck and spine, torticollis and lateral curvature[1] (Fig. 501).

[1] J. B. Roberts, Trans. Surg. Section Amer. Med. Assoc., 1908. p. 386.

CERVICAL RIB.

This extra portion of the skeleton may appear as a slight elong of the transverse process, or it may be complete, and articulate wit sternum. Its existence has only been discoverable since the employ of the X-ray (Fig. 175, p. 254). Unless its presence produces pressure some adjoining structure, its removal is unnecessary. A thirteentl is occasionally present but seldom produces even discomfort.

Symptoms.—The symptoms without the assistance of the X-ra often confusing. A hard tumor can sometimes be felt above the cla Pressure upon the nerves may give neuralgia or neuritis; sharp or tingli stinging pains may radiate down the arm. In other cases partial para symptoms, numbness and muscular cramp are noted and aneurism o subclavian has been suspected.[1] Pressure on an artery may even pro gangrene.

Treatment.—If there are serious symptoms, complete excision o rib should be performed. A horizontal incision above the clavicle scapula along the course of the rib will permit its resection. The pe teum should NOT be preserved.[2] Removal will sometimes cure an obst neuralgia or neuritis.

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[1] Murphy, Annals of Surg., xli, 399.
[2] Keen, Am. Jour. Med. Sci., Feb., 1907.

CHAPTER XXII.

SURGICAL CONDITIONS OF THE ELBOW-JOINT.

ELBOW TUBERCULOSIS.

THE elbow is the joint of the upper extremity most commonly affected by tuberculous bone disease, and on account of the complicated character of the articulation is liable to final destruction of the articulation, especially if wrongfully treated for rheumatism. Etiology and pathology have been already discussed (p. 368). For microscopical appearances of joint tuberculosis see Frontispiece.

Symptoms.—Following a slight injury, the tuberculous process commences in the epiphyseal portion of the ulna or humerus and rapidly extends to the joint. Moderate flexion is an early symptom, with swelling observable on either side of the olecranon. Tenderness rather than pain is the first symptom, but later, typical starting pains may occur. Thickening about the joint with induration speedily follows, the swelling becomes great, atrophy of muscles, suppuration and ankylosis ensue. The sinuses lead down to carious bone and the whole region becomes a pulpy indurated mass, as in white swelling of the knee.

If pus forms, it will discharge posteriorly on one or other side of the triceps, or over the head of the radius anteriorly, or at the outer side of the biceps tendon.

Diagnosis.—Differentiation from the various non-tuberculous diseases, discussed on later pages, will be decided by the clinical symptoms and the X-ray.

Prognosis. — The prognosis is usually favorable if the tuberculous character of the disease is diagnosed early and properly treated for two or three years. Fig. 502 shows the amount of flexion and extension movements secured by prolonged fixation in a case that when first seen seemed certain to advance to suppuration.

Treatment.—Rest upon a fixation splint of plaster-of-Paris, at right angles, is the first indication. Plaster is preferable to leather, wood, tin, or binder's board, since it is less liable to be disturbed or removed by patient. A sling should also carry the weight of the arm and hand. If ankylosis is to result, the right-angled position is the most serviceable one. External applications are of little value except the passive congestive treatment by elastic band (Bier) with cupping and hot air. Cataphoresis of iodine, X-ray and Finsen therapeutics have not proven satisfactory in arresting the process. If the joint is fixed at an undesirable obtuse angle, it may be moved slowly by gentle repeated flexions or by a short sling supporting only the wrist, or by frequently changing the angle of a splint, or more speedily by gentle correction under an anesthetic. Aspiration and injection of formalin or iodine are helpful (p. 396). If the case progresses rapidly to destruc-

tion of bone, an ERASION of the carious bone through lateral incisions, with cutting away of all the diseased synovial membrane, will result in a serviceable joint. An X-ray picture will assist in locating the diseased foci. As a rule, however, early EXCISION is the better operation, especially in adolescents and adults. If the process is extending, an incision may be made for three or four inches longitudinally directly through the triceps and along the ulna, or the olecranon may be sawn across, or the joint may be reached by two lateral incisions. The ulnar nerve should be carefully avoided if the H-incision is employed. In late resections with many sinuses, the incisions will be modified. The periosteum should be carefully stripped from the bones and the soft tissues carefully pushed aside. The diseased portions of humerus, ulna and radius are then removed by a keyhole or

FIG. 502.—Flexion beyond the right angle and full extension. The result of two years' treatment by plaster casts, at varying angles. The case when first seen was typical of tubercul sis with induration and complete fixation of elbow.

chain saw. If the epiphyses and the triceps and biceps can be saved, a useful joint can be secured by the early commencement of active and passive movements.[1] The dressing for the first three weeks should be a fixed one with plaster-of-Paris made removable in anterior and posterior halves by cutting before it has completely hardened (p. 244). If suppuration continues, a bracketed splint may be used and curetting employed in addition to elastic constriction, cupping and injections of tincture of iodine or bismuth into the sinuses (p. 100). Erasion in children will often give an elbow with excellent motion and good muscular power (Fig. 503).

If ankylosis occurs in bad position, a movable joint may be secured a year later by excision and the arthroplastic insertion of flaps of fascia and fat between the ends of the bones.[2]

If the clinical symptoms and the X-ray show extensive bone disease, especially in large adolescents and adults, amputation is advisable.

[1] Ann. of Surg., Oct., 1907, xlvi, 617.
[2] Murphy, Tr. Amer. Surg. Assoc., xxii, 315.

CUBITUS VALGUS AND VARUS.

In cubitus valgus, with the hand in full supination, the forearm is *abducted* at the elbow toward the radial side; in varus, it is *adducted*. Lateral deviations may also occur in extreme rhachitis. The congenital variety is usually associated with bony deficiencies.

FIG. 503.—Result of erasion of elbow, followed later by tuberculosis of both hips.

Acquired cubitus varus or gunstock deformity at the elbow following fracture of the inner condyle of the humerus is not an uncommon condition, owing to the fact that many surgeons attempt to secure a position of the forearm in a straight line with the upper arm, which is an anatomical error (Fracture, p. 342).

If the deformity is marked and disabling, an osteotomy of the humerus, with correction, will give an improved arm (Rickets, p. 290).

ELBOW, SPRAIN.

Sprains and strains of the elbow are common and are usually occasioned by forcible backward or lateral bendings at the joint. The ligaments may be torn or stretched and the periosteum lifted. Immediate tingling pain and partial disability will result if the ulnar nerve is injured.

Many errors have occurred where "only a sprain" has been diagnosed when a fracture was actually present. Fracture at or near the elbow is so common in children that its presence should be suspected in any severe injury, and ether and the X-ray employed to assist in diagnosis (Fracture, p. 341).

Contusions of the joint capsule and synovial membrane on either side of the olecranon may occur, sometimes followed by synovitis and effusion. These will require first, rest, then adhesive plaster or plaster-of-Paris fixation, with aspiration if necessary, the treatment being similar to that recommended for sprains of the ankle (p. 549).

Tennis Elbow.—The tennis elbow is a strain or sprain of the ligaments or muscles, with chronic effusion into the joint. Pain, tenderness on pressure, limitation of motion and disability will be present. The supinator brevis may be torn or the periosteum stripped up. Hot soaking, rest in a sling, adhesive plaster strapping and later massage and hot air baking (Fig. 320, p. 364) will be required.

ELBOW, ANKYLOSIS.

Ankylosis may follow tuberculous disease of the elbow or fracture or other injury of the joint, with fibrous or bony adhesions that have occurred in spite of the ordinary forms of treatment (Fig. 504).

Ankylosis of the elbow is a condition, not a disease but the result of a disease, and each pathological condition is to be considered in the treatment of this unfortunate result. Tuberculosis, syphilis, gonorrheal or other infective arthritis, traumatism, ostitis, osteoarthritis, rheumatism and other causes frequently result in a slight or complete fibrous or bony union of the opposing joint surfaces.

Treatment.—The technic of FORCIBLE MANIPULATION, or brisement forcé, under anesthesia is important. The force must be applied with judgment, patience and thorough anatomical and surgical knowledge. In children any artificial leverage is unjustifiable, as the surgeon's hands should intelligently guide the amount of force expended. Undue force may tear off an epiphysis, while slow, careful efforts will often succeed in restoring a joint apparently hopelessly lost. Section of the biceps tendon is rarely necessary.

F[illegible] from tuber-[illegible]

Ankylosis from arthritis deformans will be best prevented by insisting upon the use of the joint in spite of pain. The pain induced by movement can be relieved by the high-frequency current (Arthritis Deformans, p. 590).

RHEUMATIC ANKYLOSIS is rare in children. The majority of cases of so-called rheumatism are errors of diagnosis due to the carelessness or ignorance of the physician; this error is unjustifiable since mono-articular rheumatism in a child is never present without definite and distinctive symptoms. The majority of cases of so-called rheumatism will too late show themselves to be tuberculous or septic in origin. Ankylosis resulting from true rheumatism can usually be broken up by repeated etherizations and manipulations followed by hot air baking and persistent active and passive gymnastic movements (p. 268).

Cases of GONORRHEAL ARTHRITIS which have not been treated by early operating, washing and disinfection, but have been allowed to ankylose, should be examined carefully both clinically and by the X-ray, and an attempt made to restore motion by gentle but repeated efforts under ether. Unless the resultant inflammation is severe, a splint is not employed but the patient is urged to continue motion in spite of pain. As soon as

possible the surgeon should commence pa
massage, dry heat and long-continued gyr
Arthritis, p. 584).

SEPTIC INFECTIONS of the elbow are o
and are neglected. The ankylosis that fo
is usually the result of suppuration that
incision, washing, disinfection and draina
is evident and the position faulty an exci
good motion may be secured by persist
assisted by gymnastics (Infectious Arthriti
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FIG. 505.—Pneumococcic infectious arthritis of elbow, with symptoms mistaken for typhoid fever.

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If the clinical symptoms or the X-ra
motion, REMOVAL is the only cure, the inc
radial border of the olecranon.

GANGLION

Ganglion alongside or beneath the ten
with. The presence of the gelatinous fluid
produce pressure upon the median or ul

[1] Murphy, Trans. Amer. Surg. Assoc., xxii, 1904, 3

the hand. The tumor is more easily moved laterally than longitudinally. It is more deeply attached than a lipoma or a sebaceous tumor, although from consolidation it may be firm rather than cystic. It is non-pulsatile in character and the absence of pulsation or of fluctuation distinguishes it from an aneurism or an abscess or bursitis.

The bursæ mucosæ lie beneath the tendon of the triceps and also between the fascia and the tendon. A local bursitis may follow injury, or the inflammation may involve the joint, with subsequent effusion.

Strapping with adhesive plaster, or the use of a sling, or fixation will give comfort. Operation will become necessary if suppuration ensues.

Dislocation of the Ulnar Nerve.—Dislocation of the ulnar nerve from its groove occurs from accident, fracture, or dislocation of the elbow.

The nerve should be cut down upon, replaced and sutured in position or to the triceps, by a flap of fascia or periosteum cut from the neighboring tissues.

Ulnar Neuritis.—A neuritis may develop from long-continued pressure of the mattress upon the ulnar nerve, with arms lying helpless during months of severe and exhausting illness. The little finger and half of the third will be painful for months or years, with tingling and numbness, especially in cold weather. Massage and electricity will be needed.

Back-elbow. — Back-elbow is met with in patients with elongated ligaments and relaxed muscles, and is usually accompanied by back-knee, flat-foot, loose finger-joints, or paralysis (Fig. 492, p. 545).

Improvement of muscular conditions by gymnastics and massage is the only treatment. Arthrodesis is inadvisable.

CHAPTER XXIII.

SURGICAL CONDITIONS OF THE WRIST AND HAND.

WRIST AND HAND TUBERCULOSIS.

TUBERCULOUS DISEASE affecting the bones of the wrist and hand is not very uncommon in children. Its pathology and course are the same as in other tuberculous joints (p. 368).

Symptoms.—The symptoms presented will be the usual ones of tenderness, swelling and limitation of motion, caused by muscular spasm, and later, atrophy. The swelling is usually of the doughy variety,—white swelling, tumor albus,—and as the disease extends from radius or ulna to the spongy bones of the carpus, suppuration is the rule (Fig. 506). Early diagnosis is necessary and the condition should never be mistaken for rheumatism (p. 325).

FIG. 506.—Tuberculous disease of wrist with suppuration (white swelling).

Treatment.—The hygienic and constitutional measures so important in every case of tuberculous infection are discussed on pp. 380 and 385. A light plaster cast applied in the position of slight extension is the most comfortable and effective form of fixation. The carpus should always be fixed, but in slight cases and when active symptoms have disappeared, the use of the thumb and fingers is essential. The cast may be removed in two halves (p. 247) for the application of elastic constrictive hyperemic treatment (p. 388) for a portion of each day. Local pressure may be made either by flannel bandage or adhesive plaster within the cast.

Finsen and X-ray therapeutics have not proven beneficial but the region is a favorable one for IODINE ELECTROLYSIS. If the disease progresses, aspiration and injections of formalin 2 per cent. in glycerine, or of tincture of iodine and alcohol, equal parts, should be made.

Ankylosis of the wrist in straight line in neglected cases is often the best obtainable result under either conservative or operative treatment.

If bone involvement is excessive, erasion in children and excision in adolescents and adults is advisable. Amputation is rarely necessary in childhood.

ERASION AND EXCISION.—The radius, ulna and carpal bones can be best reached through very long dorsolateral incisions, curved so as to avoid as much as possible the arteries and the extensors of the fingers and thumb. The extensors and flexors of the carpus need not be especially considered. An Esmarch tourniquet will control the hemorrhage. The

periosteum and soft parts are stripped off, by periosteal knife or elevator, from the heads of the radius and ulna and from all the diseased carpal bones. Repeated erasions are preferable to excision in children, all tuber-

FIG. 507.—Tuberculosis of first metacarpal bone.

culous hard and soft tissues being gouged and cut away. The cavity is filled with tincture of iodine or with liquid carbolic acid followed by alcohol, closed and fixed with gypsum cast. If suppuration ensues, the stitches are cut and drainage inserted.

In excision the ligaments are divided, the heads of the radius and ulna extruded and divided with keyhole saw, the soft parts being protected by a curved bone elevator (Fig. 162, p. 243) or retractor. The carpal bones can then be more easily reached and removed with gouge, knife, scissors and claw forceps. The elastic bandage having been removed and hemorrhage arrested, the cavity is treated as in erasion.

The after treatment will consist of fixation of the wrist and hand upon a gypsum splint cut in half so as to be removable for dressings (p. 247). As ankylosis of the wrist is desirable, the use of the splint should be long continued, but from the beginning, motion must be allowed to the fingers.

SPINA VENTOSA.

Tuberculosis in the phalanges or metacarpals is a form of diaphyseal tuberculosis occasionally encountered (Fig. 507). The infection usually takes place in the centre of the bone but may be periosteal. The outer shell enlarges until it becomes spindle-shaped and sensitive to pressure. Perforation and abscesses are common. It is usually a disease of early life and is with difficulty diagnosed from syphilitic phalangeal disease, as the history is often misleading (p. 316).

Treatment.—Rest is best secured by gypsum fixation with adhesive plaster pressure. Elastic constrictive hyperemia may be added. If suppuration follows, the diseased bone should be curetted or the entire bone removed.

As the disease occurs most frequently in young children, treatment for congenital syphilis will be helpful even in tuberculosis (p. 317).

WRIST DEFORMITIES.

A congenital deformity of the wrist and forearm is found in the partial dislocation of the carpus from the ulna, with arching of the radius.

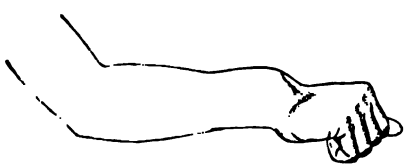

FIG. 508.—Deformity of wrist with arching of radius.

In a case reported by the author[1] the defect was congenital but was also hereditary, the mother presenting the same deformity, with weakness at both wrists (Fig. 508). Not only was the hand thrown forward but distortion of the second row of the carpus was marked. Osteotomy of radii and ulnæ brought the hands into much better relation to the forearm, and, followed by muscular movements, resulted in greatly increased power and usefulness of the hands (Fig. 509).

A condition resembling dislocation may occur in any deformation of the lower end of the radius or ulna, especially if one bone is absent (Congenital Deficiencies, p. 746). The alteration in shape may be such as to push forward the os magnum. Rarely the carpus articulates with one bone only, owing to deficiency of the lower end of the other.

[1] Willard, Amer. Med., April, 1901; Brinsmade, Annals of Surgery, xlvii, 794.

An acquired deformity is sometimes found in badly united fractures, especially those of the greenstick variety where the bone has been bent; or in epiphyseal injury, or in extreme cases of rickets, or paralysis with relaxation of ligaments. Again, the ligaments may be destroyed by tuberculous or other degenerative process and the carpus allowed to slip from its position. The X-ray is of great benefit in diagnosis.

FIG. 509.—Osteotomy of radii for correction of deformity shown in Fig. 508.

Idiopathic progressive curvature or spontaneous subluxation, sometimes known as MADELUNG'S DEFORMITY, may occur from relaxation of ligaments, with curvature of radius.

Treatment.—Muscular exercise can accomplish but little except in the paralytic cases. The wearing of a splint is vexatious (Fig. 510), but

FIG. 510.—Apparatus for wrist-drop and ischæmic paralysis. (Gill.)

sometimes necessary. The deformity is usually best relieved either by osteotomy or by open section and removal of contracted tissue upon the concave side, together with forcible reposition and fixation for a long period of time, followed by massage and voluntary and involuntary movements (Fig. 200, p. 271). In acquired paralytic cases tendon transplantation (p. 630) or arthrodesis will give corrective improvement.

STRAINS AND SPRAINS

Sprains are exceedingly common injur
constant use. Two most unfortunate errors
one to permit a fracture of the lower end of
the other is to carelessly term the conditio
necessary surgical means of relief. An X-r
fracture of the radius or carpus when non

FIG. 511.—Sprain of wrist, without fracture.

occupation demands hard usage, a plaster
acute symptoms having subsided, voluntary
by more active measures, massage and ele
cold and hot bathing and massage will com
or iodo-vasogen or the application of equal p
mercury, belladonna and opium each night
Soaking the hand in very hot soapsuds p
increase efficiency. Tenosynovitis requires

In SEPTIC INFECTION of the tendon shea
(Fig. 512), early free incision to take off te

followed by cups and hyperemic constriction (Bier) for several hours daily. The incisions in extreme cases may be necessary from fingers to elbow. Wet antiseptic dressings are the most comfortable. After a bacteriological investigation of the infecting micro-organism, the proper antistreptococcic or staphylococcic bacterin should be employed hypodermically. Voluntary motions of fingers are allowed as early as possible, followed by gymnastic exercises and hot-air baking.

FIG. 512. — Septic tenosynovitis from bird shot.

WRIST GANGLION.

A ganglion is the protrusion or hernia of the synovial lining of a tendon sheath, evidenced by an elastic sessile cyst filled with gelatinous fluid. Its most common position is on the back of the wrist or hand but it is also found in connection with the tendons of the fingers.

Compound ganglia frequently communicate with the carpal joints or wrist and if tuberculously infected may destroy the joints and bone. Small melon-seed bodies contained in the cyst give the sensation of crepitation. The resultant disability, pain and weakness are often serious.

Treatment.—Aseptic puncture of a simple ganglion by a slender tenotome or bistoury introduced through the skin at a distance from the tumor will usually effect a cure if subsequent pressure by an aseptic pad is applied. If the tumor returns, the complete cyst will require excision. In compound ganglia the dissection will need to be extensive.

CLUB-HAND.

Club-hand is frequently coexistent with club-foot or other congenital malformations (Fig. 513). The hand may be displaced either backward or forward or laterally, and is often associated with internal rotation of the arm or deficiencies of bones (Fig. 516, p. 575). The deformities may be occasioned by heredity, by faulty position in utero or by intra-uterine bands, but is more frequently due to defective control of development in embryonic life. The common obliquity is toward the ulnar side, but the thumb may be absent (Congenital Deficiencies, p. 746).

Treatment.—Immediately after birth the hand should be frequently manipulated and brought as far as possible to the normal position many times in the day but without giving pain to the child. Later it may be held in position by plaster-of-Paris or leather splint. Still later, FORCIBLE STRAIGHTENING under ether and fixation in an overcorrected position, followed by MECHANICAL appliances of leather, jointed at the wrist to allow anteroposterior motion only, will be serviceable. Muscular exercise and massage must be continued for years. If the tendons continuously resist treatment they should be divided and an OSTEOTOMY of the bones of the lower forearm performed which will assist at least in cosmetic improve-

ment (Fig. 514). An arthrodesis or osteoplastic operation fixing the hand to the deformed forearm is often advisable.

FIG. 513.—Congenital club-hand (after Sayre).

FIG. 514.—Appearance of club-hands greatly improved by osteotomies (after Sayre, Thomson).

CONGENITAL AND ACQUIRED DEFORMITY OF FINGERS.

Deformities of fingers and hand are common.

A peculiar instance of CLEFT HAND OR LOBSTER-CLAW, occurring in four members of the same family, presented itself to the author, as shown in Fig. 704, p. 751. The third, fourth, fifth and seventh child had these deformities in hands and feet, while five other children were normal. Both parents were normal but were so ignorant that the history of previous generations could not be secured.

FIG. 515.—One thumb congenitally distorted across palm. Fingers of opposite hand also contracted. Both feet boat-shaped from projection of scaphoids. Thumb straightened later by lengthening of tendon. Feet corrected by wedge-shaped tarsectomies.

These deficiencies are usually attributed to amniotic disturbances, bands, amputations, etc. The influence of maternal impressions is not proven and is very problematical, while injuries during the first month of pregnancy when the ovum is still in a plastic state can readily account for many of the important coincidences. Plastic operations will sometimes improve these deformities, but cannot of course replace absent parts.

When the cleft extends back to the carpus, a plastic operation may partially improve the unsightliness, but a prosthetic apparatus supplying the defective parts is better. When covered with a glove, the artificial hand is a decided cosmetic improvement.

Distorted Fingers.—The fingers may be deformed congenitally (Fig. 515) or from acquired contractions following burns or traumatisms. Congenital defects may be remedied by manipulation commencing soon after birth. A distorted finger can be straightened by a silver or aluminum ferrule applied to the first and second phalanges while the terminal phalanx is enclosed in a thimble. The apparatus is jointed opposite the end of the second phalanx, lateral motion being regulated by a fine screw. This appliance can be worn at night without discomfort or interference with the day motions. If the tendons are contracted they may be tenotomized. Section of the contracted ligaments is helpful and is not likely to result in a stiff finger if followed by manipulations.

FIG. 516.—Fingers represented only by five slight projections. Carpal and metacarpal bones not distinguishable.

The contraction following injury or burns can frequently be relieved by a plastic operation. When extensive sloughing results from sliding down a long rope, the condensed tissue should be removed by section and healthy skin borrowed from the neighboring region for a plastic flap. If such borrowing is impossible, the hand can be placed in an easy position and a skin flap taken from the front of the thorax or abdomen and turned back over the required area. It is better to leave this flap attached at one of its longitudinal sides, in order to preserve its vitality. In a week it may be cut loose from its base and stitched into position. Another region from which skin can be readily borrowed, especially in girls, is secured by placing the hand against the outer side of the thigh and forming the flaps similarly. In either position the arm should be permanently fixed with plaster-of-Paris

encasement until such time as the second
this, finger motion is advisable to prevent
grafts are useful in slight cases (p. 223).

Brachydactylism.—A phalanx may be
of an entire finger or fingers is denominate
constrictive bands or adhesions are usual
formation (Fig. 516).

Macrodactylism—Congenital Hypertrop
cal enlargement of bones and soft tissues m
several. The growth may be angiomatous
gram will disclose the bony alterations.
removed or the finger amputated.

SUPERNUMERARY FINGERS O

This condition is not uncommon and is
ity sometimes lasting through several gen
are common but as many as ten or twelv
feet have been found. They are sometim
tions or the metacarpals may be fused; at o
are defective, owing to a congenital malfor

An X-ray will disclose the fusions of b
infants.

In order to relieve the mother's ment
tional fingers should be performed, if possib
If there is no bony connection, only local
can be left until a later period.

WEBBED FINGERS OR S

Webbed fingers are congenital, or ac
injuries which are common to childhood
frequently coexistent with various deformi

FIG. 517.—Middle and ring fingers webbed to the tips. Separated later by plastic operation.

separate the fingers with strips of sterile
strips of adhesive plaster for a long time

division of the web, a V-shaped flap may be secured either from the dorsum of the cleft or from the palmar surface or from the sides of the phalanges, this flap being turned in to the cleft so as to prevent union.

Another operation (Didot) consists in taking a plastic flap from the dorsum of one finger and from the palmar surface of the other. These two flaps, after division of the remaining web, are wrapped around the opposite finger and stitched in position. The precaution of separating the fingers, however, is the most important one. Should these operations fail from any cause, a pedunculated flap may be temporarily applied from the outside of the thigh and the hand held in position by gypsum for a week, or a flap may be taken from the front of the chest or abdomen (p. 575).

Another operation consists in buttonholing the base of the web and carrying through this opening a skin flap taken from the dorsum, and suturing it in the palm. When the opening is thoroughly lined with epithelium, the web may be divided and plastic covering of the sides of the fingers neatly formed. A silver wire seton through the base of the web is also sometimes employed, the wire remaining *in situ* until the hole is thoroughly lined with new skin, after which the web is divided and a plastic operation performed.

MALLET OR DROP-FINGER; BASEBALL FINGER.

A blow upon the end of the last phalanx is the most frequent cause of this deformity, the third phalanx being partially displaced upon the second, either backward or forward, together with a tear of the anterior or posterior ligaments and sometimes fracture of the condyles. If extensive, the phalanx may be driven either into extreme hyperextension or hyperflexion, according to the direction of the impinging force. The tendons may be ruptured or stretched and weakened.

Pain, swelling and tenderness speedily follow the injury and subsequent inflammatory thickening renders the finger sensitive for a long time. The joint can be extended passively but not voluntarily.

The repetition of the traumatism frequently results in a permanent distortion of the phalanges accompanied by thickening about the joint from subacute arthritis.[1]

The baseball finger differs from the mallet finger in the fact that although the deformity is somewhat similar, yet in the former there is a partial or complete dislocation of the distal upon the proximal phalanx and normal extension cannot be made without force, while in the latter condition the tendon may be contracted.

Treatment.– Prolonged soaking in very hot water will hasten the cure. After reposition of the displacement by traction and forcible extension, the finger should be fixed by a small palmar splint held in position by turns of narrow ADHESIVE PLASTER BANDAGE until the ligaments have had time to heal. When chronically or frequently displaced, cutting down upon the ligament and stitching the capsule and tendon will be helpful. Hot-air baking and massage will increase joint motion. Absorption will be has-

[1] Archiv. Rontgen Ray, July, 1907.

tened by the local application of iodine, or by an ointment of iodine, mercury, and belladonna or by iodine petrogen.

In many untreated cases permanent ankylosis results with bony or fibrous deposits.

DUPUYTREN'S CONTRACTION OF FINGERS.

Contraction of the palmar fascia (Dupuytren) is so rarely found in children that it should not be confounded with congenital contraction of the tendons. It is rarely seen under sixteen years of age (Tubby) and seems to be hereditary, as several members of a family may be similarly affected.

Spontaneous cicatricial contraction of the palmar fascia due to slight but constant occupational traumatisms in a gouty or rheumatic individual results in permanent flexion of one or more fingers. The callous-like band felt in the palm is not tendon, but a dense white fibrous tissue, the palmar fascia and its digital prolongations thickened by a chronic hyperplasia. The fingers, especially the ring finger, are forcibly flexed, sometimes to the extent of making ulcerative pressure upon the palm. Extension is impossible. The interference with use of the hand, particularly in a working boy, is serious. The condition is more common in males than in females owing to the greater traumatisms inflicted on the male hand, especially in baseball days. It may be diagnosed from contracted tendon by the mobility of the tendon and the dense condition of the bands when the wrist is flexed. Anatomically this condition is readily explained by the divisions of the palmar fascia.

Treatment.—The treatment consists either in multiple subcutaneous tenotomies of the fascia, or better, in laying off an inverted U-shaped palmar flap over the contracted area and carefully dissecting away the entire fibrous cicatricial mass under the strictest aseptic precautions, until free movement is secured. This may be done under local or nerve infiltration anesthesia. The fingers should be dressed in the straight position until healing has occurred, after which persistent oil massage and movements should be practised.

Injections of thiosinamin and fibrolysin have been tried to prevent recontraction but without apparent benefit.

TRIGGER, LOCK, SNAPPING, SPRING OR SPASM FINGER; DIGITUS RECELLENS.

This condition consists in a temporary flexion of a finger, which when released by extensor action springs suddenly backward, sometimes with a click. It may be caused by repeated minor traumatisms producing nodulations or loose bodies, or by tumor or circumscribed fibrous hypertrophies within the sheath of the tendon, or by foreign bodies. The deposit is usually found between the digitopalmar fold and the first palmar crease.[1] The chief symptom—sudden extension—is characteristic. This is sometimes painful. If painful, or if interfering with manual labor, the sheath may be opened, split and the offending source removed.

[1] Weir, Trans. Sec. Surg. and Anat., Amer. Med. Assoc., 1907, 395.

In operating for the relief of this condition, either general or cocaine anesthesia may be employed. The finger should not be placed upon a splint, as it is important that the tendon movements be secured as early as possible.

MUSICIAN'S FINGER.

To the late Dr. Forbes[1] is due the credit of discovering the importance of the tendinous offshoot passing from the extensor of the middle or of the little finger, to the extensor of the ring finger. All musicians have experienced the difficulty of raising the ring finger independently from the piano keys while the tips of the other fingers are upon them, due to the absence of an individual tendon to this finger. This interference with independent action and forcible use is decidedly detrimental to rapid instrumentation.

The operation, under cocaine or ethyl chloride anesthesia, consists in aseptic subcutaneous tenotomy of this cross tendon, thus adding sometimes as much as 50 per cent. to the required extension elevation of the finger. The tiny wound is closed with a few drops of collodion and no splint applied.

Washerwoman's Strain.—In large girls or athletic boys the tendons of the extensor muscles of the thumb may be strained. Inflammation of their sheaths will result in an effusion giving a peculiar creaking sensation on muscular contraction. Rest and adhesive plaster strapping are helpful.

[1] Forbes, Trans. Phila. County Med. Soc., Nov. 12, 1884.

CHAPTER XXIV.

NON-TUBERCULOUS DISEASES OF THE JOINTS.

INFECTIOUS ARTHRITIS—SEPTIC ARTHRITIS.

ARTHRITIS the result of some form of micro-organism or of its toxins is not uncommon. Any pus-producing organism may cause this condition, but gonococcic, pneumococcic, streptococcic, staphylococcic, influenzal, rheumatic and typhoid germs are the most common varieties. The saprophytic organisms are not to be found in the joints with any certainty. One or many joints may be involved. The toxemia may develop slowly or suddenly, and the infection may pass on rapidly to suppuration or to plastic or fibrous or bony ankylosis.

Pneumococcic and streptococcic invasions are more sudden than typhoid. Gonococcic infection is usually sudden, frequently following a cessation of the urethral discharge. Atrophic or rheumatoid arthritis and hypertrophic or osteo-arthritis are much slower in development and do not tend to suppuration (Arthritis Deformans, p. 585). Increased leucocytosis is frequent in infectious arthritis and hemoglobin percentage is high.

Causes and Symptoms.—In infants the condition may arise from an infected umbilical cord or nursing from a septic mother.[1] It may follow typhoid fever,[2] scarlatina, measles or other low forms of disease, but an error is often made in failing to diagnose the dangerous septic symptoms and calling the disease typhoid, without searching for the true cause. A Widal reaction is deceiving.

Septic Arthritis.—In staphylococcic sepsis, as a rule, leucocytosis is pronounced, but occasionally the granulocytes disappear and leucopenia appears. This diminution is not necessarily the result of defective lymphoid proliferation in the bone marrow.[3]

Infectious arthritis often follows gunshot or other penetrating wounds of the joint (Fig. 486), or severe traumatisms or puerperal sepsis. In mild infections, pain on motion, tenderness, stiffness and slight effusion occur, followed by more or less fibrous ankylosis that will require a long treatment by massage, manipulation, and hot air, to overcome stiffening. Cases of true rheumatic inflammation will be evidenced by fever, heat, sweatings, swelling, and by a sudden onset without any injury. When suppuration is present, a diagnosis of rheumatism may be eliminated. The joint invasion is frequently sudden, with local symptoms of pain and swelling, while the dangerous constitutional symptoms of septic infection, fever, chills, and delirium, will be unjustifiably mistaken for rheumatism, typhoid fever

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[1] Townsend, Trans. Amer. Orth. Assoc., 1899.
[2] Keen, Surg. Complications of Typhoid Fever.
[3] Med. Notes and Queries, Nov., 1907.

or other disease. The joint infection may arise by extension from a neighboring infectious osteomyelitis (p. 594) or epiphysitis (p. 599).

Diagnosis. - The diagnosis is facilitated by cultures from the joint fluid. Pneumococci, streptococci, gonococci and many other organisms have been found. The early diagnosis of a slowly invading infectious arthritis from a joint tuberculosis is sometimes difficult. An X-ray will lend valuable assistance if the patient is not too young.

Prognosis. In young children and in adolescents of poor resistance the infection may go on to suppuration, but in strong individuals the result is usually a false ankylosis which will most seriously stiffen or fix the joint unless prolonged and vigorous treatment is instituted. Permanent rigidity is the rule if this course is not adopted.

Treatment. - Constitutional and supporting measures are essential. The question of joint destruction will depend largely upon prompt treatment and the resistive power of the individual. Temporary effusion in the joint and ankylosis are common even in non-suppurative cases and a long period of massage and forcible passive movements will be required.

Bacterin therapy with the vaccine corresponding to the invading organisms, as determined in the laboratory and guided by the clinical symptoms or by the opsonic index, will greatly assist in cure, AFTER proper operative measures have been applied.

In the early stage, diagnosis and treatment of the cause are of primary importance. Complete rest in bed with the application of heat or cold and of a fixation splint or removable plaster-of-Paris casing is the rule in mild cases.

In moderate infections, as soon as effusion occurs, early aspiration will relieve tension and may permit the recognition of the invading bacillus by the microscope or culture or inoculation. The blood should also be examined if symptoms permit delay. The Widal test will usually be negative but symptoms of typhoid fever are common (Gonococcic Arthritis, p. 582). If suppuration is evidenced by rise of temperature or chills or marked local tenderness and swelling, and the exploratory aspiration shows pus, immediate incision should follow. ARTHROTOMY and flushings with formaldehyde, iodine or carbolic acid, with or without drainage is early demanded. In pneumococcic infections, the question of arthrotomy will depend upon the severity of the symptoms. An X-ray will give some additional knowledge. In severe virulent infections, traumatic or otherwise, the hip, shoulder or other joint should be promptly [illegible] its fullest extent. At the knee free incision from side to side is [illegible] across the tendo-patellæ or the patella itself, so as to give an absolute free exposure to every corner of the joint when it is flexed (p. 542). Careful antiseptic washings and irrigations with bichloride 1:1000 or 1:2000 or mopping with pure carbolic acid and alcohol followed by [illegible] of the joint and fixation, will save life and joint. Burrowing pus must be liberated freely. Subsequent resection of the joint or AMPUTATION will be necessary when treatment has been delayed. Increased phagocytosis may be stimulated by the chemotaxic effect of injections of sterilized horse serum, salt solution, or tuberculin or by an elastic bandage. Infectious septic arthritis has been benefited by rectal injections of collargol, gr. 2, in warm water, and

by continuous irrigations with weak solution of formaldehyde, but only after thorough opening of the joints.

If the joint is not seen until it has become ankylosed in bad position, forcible attempts should be made under ether to restore function, to be followed by both passive and active movements of the joint, with massage, gymnastics, hot-air baking, the X-ray and high-frequency therapy.[1] In old ankyloses with severe deformity, osteotomy and tenotomy or erasion or excision become necessary. If acute osteomyelitis is present, a free and open operation if done in the first twenty-four or forty-eight hours may save destruction of joint and of life (Osteomyelitis, p. 594).

GONORRHEAL ARTHRITIS.

Gonorrheal arthritis may be met with even in infants and young children or in lewd adolescent boys or girls. This form of arthritis is a SEPTIC INFECTION of a joint by the gonococci or their toxins. It is not a rheumatism and should never be called *gonorrheal rheumatism.* It is a constitutional disease with local manifestations either in a joint, or in surrounding tissues, the arthritis being only one of the evidences of the absorption of the poison (Infectious Arthritis, p. 580). A urethral or vaginal discharge (Gonorrheal Vaginitis, p. 171) may be present at the time or it may have ceased either immediately before or at a considerable time previous to the outbreak or may have remained as a gleet.

Holt states that twenty-six cases of gonococcic arthritis, mostly in the smaller joints, occurred during an epidemic. Nineteen cases were in boys with genital lesions, but only two of the seven girls affected had vaginitis. A joint infection may even follow a gonorrheal ophthalmia neonatorum in an infant.

This form of infection occurs in three to five per cent. of cases of gonorrhea, most commonly in the knee. It may be mono-articular or poly-articular, knee, hip, shoulder, wrist or tarsus being involved. The plastic type of exudate is more common than either the serous or purulent form and fibrous ankylosis is common. Gonorrheal infection of the bursæ and tendinous sheaths is another variety. In addition to infection of several joints, gonorrheal ophthalmia and conjunctivitis, iritis, keratitis, involvement of sphenoidal cells or metastatic conditions may develop.[2]

Symptoms.—The invasion of a joint may come on early in a urethritis but frequently appears as late as the fifth week or even months later from toxins. Constitutional symptoms are fever, local and general, with evidences of sepsis. The cartilage becomes eroded and pus forms. Swelling, effusion and pain are present in varying degrees. The surgeon should always, in every suspected case, personally examine the urethra or vagina, making cultures from any discovered discharge, since the patient's word is always unreliable. In mild attacks, only the synovial membrane may be involved, but in more severe cases, infiltration about the joint is present. The symptoms are those of septic arthritis (p. 580) rather than of rheu-

[1] Hand and Jopson, International Clinics, vol. iv, Series 18.
[2] Posey, Amer. Ophthalmology, Jan., 1907.

matism. Muscular spasm, early flexion and fibrous ankylosis in the deformed position, will speedily follow (Fig. 518).

The micro-organisms undobtedly secure entrance from the blood or lymph streams and are admitted to the joints least able to ward off this enemy. Whenever the invading micro-organisms gain a foothold in the joint or other tissue, phagocytosis is at once aroused and the attack repulsed or modified. The destroying power of the leucocytes can be increased by raising the OPSONIC INDEX of the individual (p. 391). The proliferation of the connective-tissue cells may, if not controlled, lead to fibrous or more dense ankylosis. In gonorrheal osteo-arthritis, bone rarefaction can be shown by the X-ray very early, even in the first few days. If there is no rarefaction the disease has probably settled within the capsule.

Diagnosis.—Diagnosis from RHEUMATISM and GOUT is made by investigation as to the cause, the presence of a urethritis, vulvovaginitis or ophthalmia neonatorum and the discovery of the gonococcus in the effusion. Apart from the microscopical investigation, the diagnosis is established from the fact that rheumatism is usually polyarticular,—that it shifts from one point to another; sweating is profuse and the general range of temperature higher. In children acute epiphysitis may be confounded with this specific arthritis, as may also various forms of septic and syphilitic ostitis. In MIXED INFECTIONS the symptoms will be those of sepsis but the case is often maltreated for typhoid fever. In JOINT TUBERCULOSIS the advent is usually slow and is not accompanied by as great tenderness, swelling or redness, but rather a doughiness, together with early rigidity of muscles and fixation of the joint.

FIG. 518.—Gonorrheal arthritis with ankylosis at hips and knees.

When the diagnosis is obscure, the gonorrheal opsonic index may help. A capillary glass tube can be sent to a skilled laboratory physician and the proper bacterin to be employed can be determined.

Prognosis.—Gonorrheal arthritis in syphilitic infants infected from ophthalmia neonatorum, is usually fatal. If the infection is repelled and there is but little deposit, a useful joint can be secured. In severe cases that have not been treated early, ankylosis will often result. Suppuration will follow in mixed infections.

Gonorrheal arthritis undoubtedly tends markedly to fibrous ankylosis of the joint, but this result may be prevented by proper treatment. Many of the evil results arise from the pernicious habit of physicians in calling this disease "gonorrheal rheumatism," and scores of cases of joints infected by gonococci or streptococci are lost beyond recall through this unwarranted carelessness.

Treatment.—The first indication for treatment is to cure the urethral discharge and prevent further infection. The urethra is irrigated with weak solutions of potassium permanganate, zinc, argyrol, etc., and treated along the ordinary lines for gonorrhea.

The patient should be put in bed and kept warm and the joint elevated. The joint is fixed by a posterior plaster-of-Paris or felt or wooden splint as nearly as possible in a normal position. This FIXATION is continued for one or two weeks until the inflammatory symptoms have been controlled by ice-bags, after which time gentle voluntary motions are advisable, aided later by the surgeon. If joint effusion occurs, ASPIRATION and quick examination for the micro-organisms is practised. If this is done early and no organisms found. delay is allowable, but if the withdrawn fluid shows mixed infection, no delay is admissible. Under absolutely aseptic precautions the joint is FREELY OPENED and irrigated with mercuric bichloride or biniodide, 1 to 6000, or potassium permanganate 1 to 2000, or carbolic acid five per cent., or formalin two per cent. Lateral and posterior incisions will permit a free washing of the joint, allowing no lurking bacilli to remain.[1] The solution should be hot and generous. When serum alone is present and the washing has been effective the wounds are closed at either end and a small opening left at the centre without drainage. If the fluid is deeply turbid a gauze drain is inserted; if suppurative, a rubber tube. Thymol diiodide is dusted over the wounds and a sterile dressing and a plaster-of-Paris splint added for ten days. Gentle voluntary and passive motions are then practised, followed by massage, superheated dry air and gymnastic exercises until function has been restored (p. 235). By prompt action a large proportion of joints can be saved. If re-accumulation occurs, the process may be repeated.

Ankylosis is difficult to overcome. Under ether, fibrous deposits are loosened early and the patient encouraged to move the joint voluntarily even though pain is experienced. This operation will need several repetitions, the joint meanwhile being treated with superheated dry air, massage, forcible voluntary and involuntary movements, and gymnastic exercises by a skilled instructor. If the patient has the necessary patience and perseverance, restoration of function may be secured. In bony ankylosis in bad position, OSTEOTOMY is usually less dangerous than excision. An ARTHROPLASTY at the knee or elbow, with turning in of a flap of fascia and fat, is excellent (p. 534).

High potential electrical currents are sometimes employed locally.[2] Anti-rheumatic remedies constantly fail. Anti-gonococcic vaccine with 10,000,000 to 50,000,000 dead gonococci has been employed, with uncertain but mainly beneficial results. An autogenous vaccine may be prepared from the patient's own urethra, or a stock vaccine may be used, the latter being less effective. From ten to forty minims are hypodermically injected in the back every other day with good results, especially if used in the first ten days. Erythema and sometimes an erysipelatous blush may follow its use. Gonococcic vaccine consists of cultures of the organisms that have been killed, while gonococcic serum is obtained from the blood of an animal that has been immunized against the diplococcus. The purpose of the treatment is to increase the antibodies, but lasting immunity is not secured

[1] Willard, Gonorrheal Arthritis, Ther. Monthly, Phil., 1902; Trans. Amer. Ther. Soc., 1902; Ther. Monthly, 1902, 241; Monthly Cyclopedia, 9, 331; article on Gonorrheal Arthritis, Warren-Gould's International Text-Book of Surg., i, 712.

[2] N. Y. Med. Record, July 25, 1908.

as joint recurrence is not infrequent and in some cases decided awakening of a quiescent process has been noted. An active urethral discharge should be treated with antigonococcic serum and by the methods described in treatises on venereal disease. As gonorrheal ophthalmia may cause joint infection as well as loss of sight, the prompt instillation of silver nitrate upon the conjunctiva of the new-born should never be neglected in any suspicious case of vaginitis.

ARTHRITIS DEFORMANS.

Synonyms: Rheumatoid arthritis; chronic rheumatism; chronic rheumatoid arthritis; rheumatic gout; hypertrophic arthritis; atrophic arthritis; osteo-arthritis; metabolic or trophic osteo-arthritis deformans; dry arthritis.

Various polyarthritic forms of disease due to faulty metabolism or to some autointoxication from the digestive tract, have been classed together under the general term, rheumatoid arthritis, for lack of a better name. Many authors have attempted to separate them either clinically or pathologically, but confusion of terms still exists. Goldthwait,[1] Nathan[2] and

FIG. 519.—Bony changes with eburnation in arthritis deformans. (Adams.)

Osgood[3] have endeavored to differentiate the groups, but much further study is necessary. Possibly the best classification is into the ATROPHIC and the HYPERTROPHIC forms. Others divide the cases into the SYNOVIAL and the OSSEOUS varieties. The synovial infections are designated as TROPHIC ARTHRITIS, the osseous forms as TROPHIC OSTEO-ARTHRITIS (Fig. 519).

ACUTE RHEUMATOID ARTHRITIS in adolescents is probably due to a micro-organism, but it is not streptococcic nor diplococcic. This form often commences with an acute fever, rapid pulse, but is not accompanied by the

[1] Goldthwait, Bost. Med. and Surg. Jour., Jan. 28, 1897, and 1904, Apr. 7; Jour. Amer. Med. Assoc., Sept. 11, 1909, 849.

[2] Nathan in three elaborate articles—Amer. Jour. Med. Sci., Jan., Apr. and Dec., 1906, and Jour. Amer. Med. Assoc., July 10, 1909, 144—has entered very fully into the classification and differentiation.

[3] Osgood, Boston Med. Library Meeting, Jan. 20, 1909.

cardiac complications of rheumatism; there is sweating of the feet and hands, spindle-shaped swelling of finger-joints [1] with arthritic muscular atrophy. Although effusion takes place into several joints from synovitis, cartilage and bone are seldom destroyed and the deposit of osteophytes is rare. The bone may be easily penetrated by the X-rays, showing a deficiency at least of bone salts. The same transparency, however, is seen in tuberculosis, cancer and osteomalacia.

Rheumatoid arthritis is not common in children but has been noted as early as the second year, and has been found quite advanced at six. In the peri-articular variety and in the progressive form, Heberden's nodosities of the phalanges will occur.[2]

FIG. 520.—Arthritis deformans with deposits in knees, elbows and hands.

Causes and Symptoms. — In children, the condition is occasionally present with involvement of several joints, without suppuration or ankylosis, but with muscular atrophy and contractions. This variety is met with in children of poverty, living in unfavorable environments (Fig. 520).

CHRONIC PROGRESSIVE POLYARTHRITIS does not begin with bone proliferation or bone hyperplasia or joint deformity, these conditions being only late developments in the disease, at which time it may properly be designated ARTHRITIS DEFORMANS (Fig. 521). The atrophic and the hypertrophic forms are readily separable. Infectious POLYARTHRITIS CHRONICA VILLOSA may occur at any age, even infancy. In all of these cases the X-ray is of advantage. In the young, the polyarticular atrophic type is most common (nodular arthritis). Bannatyne,[3] Schuller and others have claimed the discovery of a special micro-organism, but other observers have failed to find any constant pathogenic germ. A polar staining bacillus has been described and its bacteriologic origin seems probable, but no special bacillus has yet been positively demonstrated, as similar changes can be produced by injections of staphylococcus cultures. Neurologists are prone to give the condition a neuritic origin, or it may be an infectious trophoneurosis. The condition is sometimes classed with the spinal arthropathies. Arterial sclerosis disturbing circulation is also claimed as a cause.[4]

Trauma is probably the exciting cause, but a latent fault in metabolism lies behind, interfering with proper nutrition, possibly the result of an albuminous putrefaction in the intestines.[5] Effusion, cartilage destruc-

[1] Guy's Hosp. Report, Bristol Med. Chir. Jour., June, 1904.
[2] Taylor, Trans. Amer. Orth. Assoc., vol. xii, 1899, 303–311.
[3] Bannatyne, Rheumatoid Arthritis, Octavo, Bristol, 1898, and Lancet, Apr. 25, 1896.
[4] Wallenberg, Zeits. f. Orth. Chir., 1909, Bd. xxiv.
[5] Amer. Jour. Orth. Surg., 1907, 61.

tion, osteophytes and bony deposits are common and the joint motion is partially or entirely lost, dependent largely upon the amount and situation of the bony deposits. In other cases the cartilage and bone slowly wear away or may be eburnated. Villous hypertrophies in addition to cartilage and bone erosion are common at the knee (Fig. 522).

If the onset is slow and gradual and without fever but accompanied by local pain, muscular spasm and atrophy, with limp and slight flexion,

its diagnosis from tuberculous joint disease is somewhat difficult. Tenderness, stiffness, swelling and pain, with progressive limitation of motion, are very constant symptoms. The fingers are often distorted backward and the toes bent.

The symptoms in children are chronically progressive, accompanied by marked cachexia, anemia, pallor, failing strength, enlargement of the articular ends of the bones, followed by absorption, atrophy, ending in

death. The second phalanges are flexed, deformities are due to deposits in the joi (Fig. 523).

POLYARTICULAR DEFORMING ARTHRI described by Still [2] is usually associated ENLARGEMENT. It is evidently an infectio

FIG. 522.—Knee-joints with erosion of cartilages and bon C. Semilunar cartilage.

at least in certain cases, of being akin to t vial type and occurs in children before s its onset, with rapid rise in pulse and te joints.[4]

Radiographic examinations, especially disclose rarefaction, decalcification, erosio and around the joints.

Diagnosis.—The early symptoms may sciatica, hip disease or sarcoma, and wil

[1] Painter, Trans. Amer. Orth. Assoc., 1901, and

[2] Chronic Joint Disease in Children; Med. Chir. Jour. Med. Sci., Dec., 1905; Schüler, ibid., Aug., 19

[3] Edsall, Archives Pediatrics, March, 1904; also April 23, 1904, and July 24, 1909, 323.

[4] Med. Chir. Trans., 1897; Bost. Med. and Surg

examination of the nude body and a consideration of the entire group of symptoms. The X-ray will assist.

Prognosis.—While remissions and exacerbations may be expected, the general tendency of the condition is very unfavorable. Slow progression for years is the rule. The course may be modified by treatment, but seldom arrested permanently (Fig. 524).

FIG. 523.—Deformities at hips and knees from joint deposits in arthritis deformans.

Treatment. — Constitutional, hygienic, medicinal, local and operative procedures will greatly alleviate the prominent symptoms of pain, disability and deformity; and as the disease is evidently one of defective metabolism, every cause of malnutrition should be investigated. Digestion, elimination and secretion should receive most careful attention. The kidneys, liver, intestines and skin should all be ultilized as emunctories.

FOOD.—The diet should be nutritious and easily assimilated; neither meat nor vegetables nor starch should be withheld unless proven indigestible for the individual. Albuminous putrefaction in the intestines can be benefited by a fermented milk diet, especially if the urine shows indican and the feces are alkaline and fetid. Fats are allowable.[1]

FIG. 524.—The deformities of arthritis deformans are usually progressive and persistent.

CLOTHING.—Warm woolen underclothes and protection of the feet from cold are essential and sudden exposures are to be avoided.

THROAT.—Some cases are greatly benefited by careful attention each day to the irrigation of the nose and pharynx with a solution of potassium chlorate and oil of peppermint or other antiseptic. The removal of adenoids and of tonsils is helpful.

GENERAL HEALTH.—Great importance should be attached to healthful and cheerful environments and the avoidance of nervous strain. A life in the open air in a sunny dry climate is essential (Open-Air Treatment, p. 380).

MEDICINES. — *Arsenic* in small doses long continued, *aspirin* and *tincture* of *rhus toxicodendron* seem to be the only remedies offering much relief, but iodide of iron, pepsin, nux vomica and other tonics should be given as needed, especially in the anemia of progressive arthritis in children. Morphia should not be given except in the latest stage. Cannabis indica, codeia, acetanilid, phenacetin, oil of gaultheria, and the salicylates, all have

[1] Andrews and Hoke, Amer. Jour. Orth. Surg., July, 1907.

their advocates. **Thyroid extract** pushed to the extent of sixty grains three times a day, relieves symptoms. Corrosive sublimate, iodine and guaiacol carbonate have been proven useful.

LOCALLY.—Local joint pain may be relieved by the high frequency current, by strapping the joint with belladonna plaster, or by liniments of salicylate of methyl, chloroform, oil of wintergreen, etc.

REST.—Rest is important in the acute stage only.

EXERCISE.—Abundant exercise out of doors increases appetite and digestion, stimulates the perspiratory glands to activity, assists both kidney and intestines in elimination. Even painful joints, except in the acute stage, are benefited by motion, and severe chronic cases can retain a certain amount of motion in the joints if they are constantly used (Fig. 525). Muscular exercises, active and passive, in a well-equipped orthopaedic gymnasium, are very helpful in giving motion to the stiffened joints. These movements should not be continued to the point of exciting pain or inflammation, but should be persistent (Fig. 152, p. 235).

FIG. 525.—Destruction of cartilage but motion still maintained by persistent movements. (Adams).

MECHANICAL MASSAGE.—Mechanical vibratory stimulation by Zander or similar machines is helpful (Fig. 522, p. 618).

MASSAGE.—Oil massage in the majority, but not in all cases, is of value in stimulating the local circulation, assisting in carrying off the abnormal products and in absorbing the swellings, but it must be employed with exceeding caution and gentleness. It is especially helpful after hot-air treatment.

HOT AIR.—Thermotherapy.—Dry hot air at a temperature of 300° to 400° F. in a special baking oven (Fig. 320, p. 364) often gives much comfort if followed by massage. The treatment should be continued for twenty to thirty minutes. The whole body can be included in the cylinder in multiple arthritis.

ELECTRICITY.—Galvanism or static electricity relieves pain and stimulates local nutrition and absorption.

HIGH FREQUENCY CURRENT.—The high frequency current seems to be the most efficient agent in diminishing pain and discomfort and is well worthy of trial.[1]

[1] Anders, Daland and Pfahler, Jour. Amer. Med. Assoc., May 19, 1906, 1512.

ROENTGEN RAYS.—A similar result is obtained in some cases by the X-ray, which also assists in absorption.

ELECTRIC LIGHT BATHS.—The elevation of temperature and the effect of numerous incandescent electric light bulbs in a special cabinet is now extensively employed and with benefit.[1]

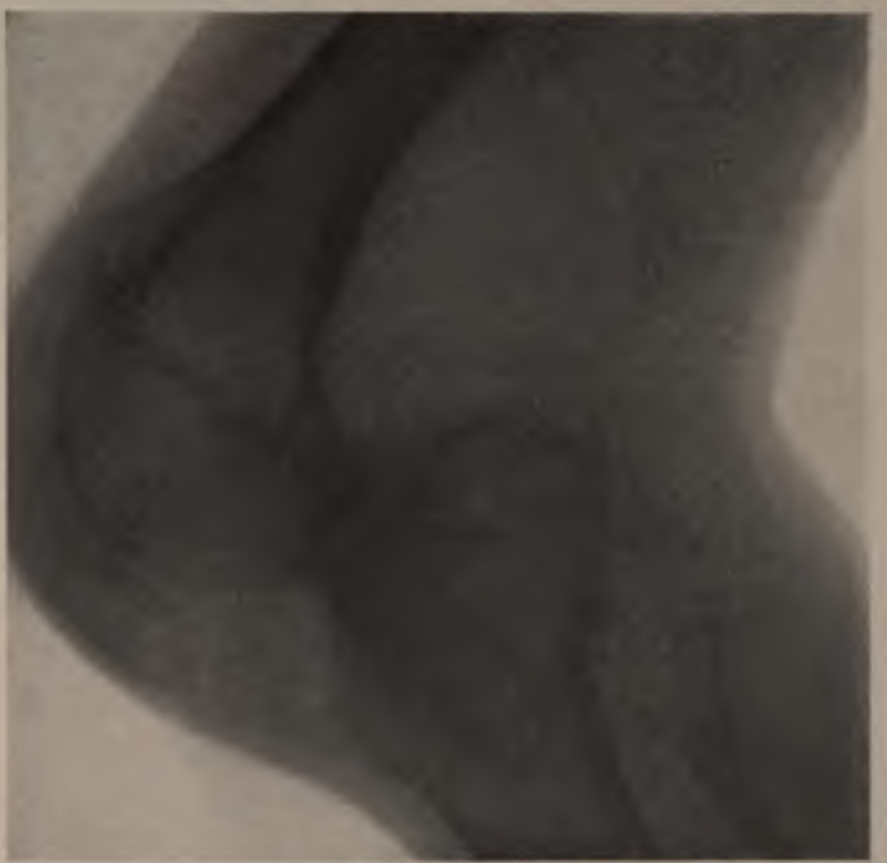

FIG. 526.—Posterior dislocation of tibia with ankylosis from arthritis deformans.

HYDROTHERAPY.—The employment of hot alkaline baths, either at the natural hot springs or in hydrotherapeutic institutions, is undoubtedly of benefit, even if not curative. At the springs greater benefit is secured by the stimulating conditions of air, climate, regulated food and exercise, which add greatly to the treatment.

PASSIVE HYPEREMIA.—Passive congestion by the elastic band of Bier (p. 388) or produced by a vacuum (p. 389) is occasionally of service in relieving pain. Locally, when other measures are unobtainable, packing the joint in hot flannels, hot sand or sawdust, or hot wet packs will often secure a good night's rest.

[1] Peckham, Amer. Jour. Orth. Surg., Apr., 1908.

OPERATIVE TREATMENT.—Forcible Correction of Deformities.—Gentle force under ether will sometimes correct a distortion that interferes with locomotion. Slow correction with apparatus is too painful.

Tenotomy.—Tenotomies and forcible straightening of knee, ankle or hip are of great advantage in placing deformed patients upon their feet and permitting locomotion with braces, canes, or crutches. Fixation in the straightened position should not be too long continued, since active and passive motions and massage must necessarily follow operation.[1]

Open Operation.—Deposits, either bony or from thickened fringes, may often be removed with advantage by knife and scissors. When the osteophytes have deprived the joint of motion, they may be chiselled away, or an excision performed, or a false joint produced by transplanting the trochanter[2] or by turning in a flap of fat and fascia.[3] Gold foil, serous membrane, pig's bladder, etc., have been used in arthroplasty.

An operation proposed by Albee for the relief of pain in old cases is to cut away a portion of the upper face of the head of the femur and also of the roof of the acetabulum, and to ankylose the joint in abduction.[4]

When posterior dislocation has occurred at the knee, excision will give partial relief (Fig. 526).

SPINAL ARTHROPATHY.

Synonyms: Neuropathic, neural and tabetic arthropathy; Charcot's joint disease.

Joint degenerations occur in the course of locomotor ataxia, syringomyelia, acute myelitis,[5] hemiplegia, and injuries or tumors of the spinal cord. Such degenerations occur in about 5 per cent. of tabetic cases and in ten per cent. of syringomyelia.

The joints most prone to destruction are the knee and hip, but shoulder, elbow and wrist furnish many of the cases in syringomyelia. The disease is usually one of later life but has been seen as early as the sixth year.

After a slight traumatism, or even when no injury is discoverable in a case of tabes, slight often painless joint effusion will be discovered, which if properly treated by rest, fixation and support will temporarily pass away. In other cases, especially at the hip and knee, slow or rapidly progressing destruction of cartilage and ligaments takes place, with thickening and grating but rarely suppuration. Villous growths, spontaneous subluxations and loss of bone may occur. The joint area is sometimes boggy, at other times thickened with deposits resembling arthritis deformans. In advanced cases, movable fragments of cartilage and bone or osteophytes are palpable, especially at the knee. The neural disease is of course in the posterior columns of the cord[6] and in children is probably due to congenital syphilitic infection.

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[1] Willard, Rheumatoid Arthritis, article in Warren-Gould's Internat. Text-Book of Surgery, 1, 709.

[2] Jones, British Med. Jour., Feb. 29, 1908; Jour. Amer. Med. Assoc., July 31, 1909, 417.

[3] Murphy, Trans. Amer. Surg. Assoc., xxii, 315, Jour. Amer. Med. Assoc., 1905.

[4] Jour. Amer. Med. Assoc., June 13, 1908, 1977.

[5] Mitchell, Amer. Jour. Med. Sci., 1875.

[6] Amer. Jour. Med. Sci., Aug., 1908.

Treatment.—When the tabes is progressive, benefit may be secured by long continued and systematic co-ordinate exercises.[1] These exercises are, however, of but little service unless supervised by a most patient and skilled teacher. The exact position for the feet, methods of walking, etc., must closely follow the painted marks on the floor.[2] Chromium sulphate internally has been recommended

The surgeon in the beginning can prevent rapid advance of the disease, by rest and fixation with gypsum or leather or steel support to the joint, thus preventing traumatism.[3] Aspiration, resection and amputation are occasionally employed for temporary relief. Mitchell recommends powerful galvanic currents to the joints together with sodium iodide. Head suspension sometimes relieves the lightning and girdle pains and the crises.

[1] Bost. Med. and Surg. Jour., 1906, clv, 699.

[2] Taylor, Jour. Nerv. and Mental Dis., 1901, xxviii, 133.

[3] Willard and Hinsdale, Med. News, Nov. 24, 1894; article in Warren-Gould's Internat. Text-Book of Surgery, i, 720.

Diagnosis.—The symptoms are distinc
mistake so often made is never justifiable
consequent delay often means death to th
whole course of the disease is also entirely d
culous infiltration in the epiphysis. Acute t
and typhoid fever will each present dist

FIG. 528.—Osteomyelitis of tibia, interfering with growth. Partial regeneration after operation but not sufficient to prevent a varus position of foot, as the fibula is hypertrophied and lengthened.

The patients are in such condition at
surgeon can rarely do more than make a qu
for the medullary cavity, to the full extent

Free hot formalin or carbolic flushi
alcohol or tincture of iodine liberally ap
General stimulation and support are essenti

It is wise to make only a furrow in the cortex and relieve tension, since if all of the medullary tissue is gouged, regeneration will be hindered and bone death increased. Epiphyses should be avoided if possible, so as not to interfere with growth. In exceptional cases amputation may be necessary, but if the pus is liberated early, great regeneration is possible at this early stage. The author has treated cases where the epiphyses at hip or knee were so entirely separated that ultimate amputation seemed probable, yet union with useful joints and good locomotion has been secured.

Speedy operation will often save much periosteum. Acute osteomyelitis following typhoid or scarlatina or pneumococcic or staphylococcic infections also requires the above prompt and early incision.[1] Large areas of denuded bone in children, if thoroughly cleansed and treated with pure tincture of iodine, may live and heal speedily.

Should the shaft of the bone die later, the tibia or fibula or radius or ulna can be removed even in their entirety, if periosteum is retained.

If the periosteum at the lower end of a tibia is carefully saved, partial regeneration will take place and cautious use of the leg will result in such hypertrophy of the fibula that the weight of the body can be borne on the limb, but varus position of the foot is ultimately likely to result (Fig. 528).

FIG. 529.—Marked increase in size of fibula, to assist the weakened tibia.

In young children with such extensive osteomyelitis of the tibia that both shaft and periosteum are destroyed (Fig. 528) and regeneration so imperfect that only the upper and lower ends of the tibia remain, an intact fibula may be transferred to the upper piece of the tibia, if after a year a radiogram shows no bone deposit. The fibula may be divided opposite the upper tibial fragment and inserted into a mortise in the tibia, all periosteum from both bones being reflected, retained and sutured and the parts firmly secured with plaster of Paris. In other cases the two bones above the ankle may be exposed, the fibula split longitudinally, one-half being carried across and mortised into the tibia, while the other half retains its original position at the outer malleolus to support the astragalus.

In fibular necrosis when both bone and periosteum are so destroyed

[1] Silver, Penna. State Med. Jour., June, 1907.

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[1] Silver, Penna. State Med. Jour., June, 1907.

that no regeneration takes place after removal of the shaft, a deformity of the foot may be overcome by an osteotomy of the tibia above the ankle and the correction of the deviation. Again, a portion of the sound tibia with retained periosteum may be split off longitudinally and bent or fractured so as to reach the lower end of the fibula, where it can be mortised and sutured.[1]

In cases of disease in the tibia,[2] the fibula will speedily increase in size to meet the necessities of the conditions (Fig. 529).

In children if periosteum is saved, almost complete regeneration will take place, an entire fibula or tibia or radius being reproduced.[3]

In subacute cases necrosed sequestra should be removed. If an entire shaft has been destroyed in spite of free incisions and drainage, a delay of a few months will permit the formation of a supporting involucrum. In old suppurative necrotic cases it is exceedingly difficult to render the cavity sterile after the removal of the involucrum, but the author once secured slow healing, after the retention for twenty-nine years [4] of a necrosed shaft.

Both autoplastic and heteroplastic methods have been tried to close the bone cavity. Decalcified bone chips have been extensively used with varying degrees of benefit, as have also ivory, paraffin, cement, plaster, copper, amalgam, blood clot, sponge, bismuth, etc. The Mosetig-Moorhof bone plug [5] consists of iodoform sixty parts, spermaceti and oleum sesami twenty parts each. Heated to 100° Centigrade, it forms a soft solid when cooled and remains solid at the temperature of the body. For use it is reheated to 50°, poured into the bone cavity, and forms the framework for bone deposition. The cavity must be sterile and dry and if possible the periosteum and soft tissues are to be closed over it.

Moore's plug [6] consists of iodine one per cent., olive oil twenty per cent. and spermaceti seventy-nine per cent. The cavity also may be filled with bismuth vaseline paste (p. 400). Another method is to inturn skin flaps to the bottom of the cavity (Neuber).

A large section of bone taken from a freshly amputated limb, or from a very young puppy or kitten, even if it does not become thoroughly vitalized will form a bridge or network into which bone cells will be deposited. The younger the animal the better, as cell activity in the first months of life is very vigorous. When a periosteal or periosteo-cutaneous flap can be secured from neighboring tissues and its vitality ensured by the retention of a broad base of blood supply, success is more certain. In some cases this base of supply may be detached after ten days of transplantation. Even entire joints, including cartilages and ligaments have been transplanted.[7] Gluck's ivory joints are foreign bodies and are ultimately cast out.[8] All of the above methods, however, frequently fail, as nature abhors foreign materials.

[1] Stone, Ann. of Surg., Oct., 1907, xlvi, 628.
[2] Huntington, Ann. of Surg., Feb., 1905, xli, 249 and 480.
[3] Johnston, Trans. Amer. Surg. Assoc., 1904.
[4] Willard, Phila. Med. and Surg. Reporter, Nov. 14, 1891, 773 and liii, 94.
[5] Deutsch. Zeit. f. Chir., lxxi, 5; Deutsch. Kongress Chir., 1906.
[6] Moore, Jour. Amer. Med. Assoc., Aug. 4, 1906, and May 20, 1905, 1582.
[7] Annals of Surgery, Nov., 1908, xlviii, 779.
[8] Willard, Trans. Phila. Coll. Phys., xiii, 1891, 58.

ACUTE INFECTIOUS EPIPHYSITIS OF INFANTS.

Synonyms: Acute osteomyelitic arthritis; acute infectious or septic ostitis

The most acutely serious of bone diseases in infants under one year of age is an infection of epiphysis or diaphysis by pyogenic bacteria.[1] In the first form the infection extends rapidly to the joint; in the latter, it may destroy periosteum and shaft in a few days (Infectious Arthritis, p. 580). The infection may be caused by gonococci, streptococci, staphylococci, pneumococci or other germs (p. 594). When the infection takes place in the first week of life, the exciting cause may be a slight local injury to the hip, shoulder or knee during birth, with the entrance of infection through the sloughing navel.

Symptoms.—The onset is sudden, the symptoms are all indicative of sepsis with high temperature, rapid pulse, chills, convulsions, stupor, local sensitiveness, pain on motion, swelling and rigidity of the joint.[2] If permitted to advance, the bone and joint are rapidly destroyed, pus forms, burrows through the tissues and death speedily follows from sepsis.

If the onset is mild the infant will be fretful, will cry when moved, especially if a certain joint is touched. These slower infections ending in death are often mistaken for typhoid fever. As a rule the condition is mono-articular and should not be confounded with rheumatism.

In older cases osteomyelitis is common, but often absent in infant life. An epiphysitis of one of the condyles of the femur may so interfere with growth as to cause either in-knee or out-knee, as seen in Fig. 232 (p. 291), from a case of the author's, occasioned by a trauma several years previously. In young children, an acute epiphysitis with escape of pus into the surrounding tissues may occur with only moderate destruction of the joint. In other cases, as at the hip, the entire head of the femur will be lost. Such infections at the hip are often mistaken for rheumatism or for tuberculous hip disease although the symptoms are rapid and acute. In older children the periosteum may be involved especially about the knee or wrist or ankle, and a dissecting periostitis follow, entirely stripping off this membrane.[3]

Defective resistance against the organisms by exhaustive disease, or possibly by congenital syphilis, may permit infection after slight traumatism at any age of childhood.

Diagnosis. To confound this disease with rheumatism which in infants is unknown, is utterly unjustifiable, as the symptoms are entirely different, being absolutely indicative of sepsis. Tuberculous arthritis has an entirely different history, as the invasion is slow and unaccompanied by inflammatory evidences. In congenital syphilis and in scurvy the infection progresses slowly and other distinctive symptoms will be present.

The X-ray unfortunately offers but little aid in the early diagnosis of either epiphysitis or dissecting periostitis in infants. In the later stages, bone changes are very evident.

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[1] Park, Amer. Jour. Med. Sci., July, 1880.
Hoffman, Med. Bull., Washington University, Sept., 1902.
[2] Stone, Bost. Med. and Surg. Jour., June 27, 1907, 842.

Treatment.—Early free incision, *i.e.*, within the first forty-eight hours, is essential. The soft bone should be perforated, gouged and the pus thoroughly evacuated. The focus is irrigated with bichloride, then treated with tincture of iodine or liquid carbolic acid, then with alcohol, and is thoroughly drained. In dissecting periostitis the membrane must be freely split open the entire extent (Osteomyelitis, p. 596). The greatest danger is in delay, since in children the pus must be quickly liberated or the joint will be disintegrated. If the operation is done early, a dissecting periostitis with subsequent necrosis or an osteomyelitis can be averted.

Combined with surgical treatment should be the immunization with the appropriate bacterin as determined by the special organism present. When the hip is involved, a plaster-of-Paris dressing is applied, including the lower trunk, hip and thigh (Fig. 166, p. 247). This can be windowed for dressings, or celluloid or leather may be employed. The cast should be shellaced and the urine and feces carefully collected on cotton and napkin to avoid soiling the cast. Other joints also can be fixed by gypsum casts.

Prognosis.—So long as this condition is treated as rheumatism and operation is delayed, just so long will the terrific death rate of more than fifty per cent. continue. If the diseased focus is reached, however, in the first forty-eight hours, not only will life be saved but a useful joint secured. Neglected cases pass through a long period of suppuration, bone and joint destruction, and, if life is spared, recover with a crippled joint.[1]

In consultation, late in the progress of the infection, the author has seen cases with suppuration so extensive that fluctuation was visible to the eye without palpation, yet were still being treated for rheumatism. In some of these patients the epiphyses have been so destroyed that subsequent amputation seemed inevitable and yet with the great recuperative ability of the child, good union and excellent locomotion have been secured. In adults, amputation would certainly have been necessary.

The subsequent ossification of the epiphysis is accomplished not by the conversion of the cartilaginous layer into bone, but by a removal of the cartilage cells by the osteoblasts, the myeloplaxes, and by the deposit of bone cells by the myelocytes.

SARCOMA OF BONES.

Sarcoma of the long bones is met with even in infancy but is rare under ten years, and increases in frequency between ten and twenty.

Sarcoma is much more frequent than carcinoma. More than one-third of all cases of sarcoma occur in bones. The femur is the bone most frequently involved in childhood, the lower end being more commonly affected than the upper (Fig. 530). Pain is usually severe and the swelling rapid, both symptoms appearing early.

Trauma is undoubtedly the exciting cause, the infectious microparasitic germs possibly having lain dormant until aroused by the injury, which injury may have been so slight as to have escaped notice at the time.

In their early stage malignant neoplasms in the neighborhood of a joint are often mistaken for tuberculosis, even by expert diagnosticians. Albumose bodies can sometimes be found in the urine. Injury often pre-

[1] Owen, International Clinics, vol. ii, 5th Series, 1895.

cedes the development of either condition by several weeks or months. In sarcoma the pain may come suddenly and at the epiphysis, but as it progresses, the joint is much less liable to be invaded, is less rigid, and the atrophy of muscles is absent. The pain, as in tuberculosis, is apt to be treated erroneously for rheumatism. The growth in sarcoma is more rapid than in tuberculosis but not as rapid as in suppurating cases of infectious epiphysitis or osteomyelitis. Swelling, pain and partial loss of motion are present in both. The swelling and thickening are firmer in sarcoma than in tuberculosis but muscular spasm is less. Spontaneous fractures are common.[1] Crackling on pressure sometimes occurs when the cortical layer is thinned but this symptom is uncertain.

The X-ray is sometimes of service in diagnosis, but sarcoma, osteomyelitis and tuberculosis also show alterations of structure (Fig. 531). Sarcoma of the ilium is not infrequently mistaken for hip or iliac disease.[2] Osteomata near the epiphyseal ends are confusing in diagnosis as are also chondromata and lipomata. The popliteal or the femoral artery may be lifted by the growth and the unusual pulsatile impulse be mistaken for aneurism. Sarcoma of the spine is usually secondary to mammary or other involvement and is accompanied by fragility of the bones and great pain. Primary spinal sarcoma is rare.[3]

FIG. 530.—Sarcoma of femur and tibia.

In a boy of fifteen seen by the author, at the end of three months after the injury, the diagnosis from tuberculosis of the knee was still uncertain. Fixation and general treatment had no effect and the rapid growth in the next month determined the presence of a sarcoma at the lower end of the femur. The diagnosis was rendered obscure by the fact that the temperature for five weeks ran from 101 to 103° and the pulse above 120. Amputation of the thigh relieved pain but in six weeks in spite of postoperative injections of the mixed toxins (p. 603), metastasis took place in the spinal canal and paralysis of motion and sensation of legs, rectum and bladder speedily followed. The boy lived in this condition for six months. The X-ray showed the irregular outlines of thinning of the femur, but crackling was not noticeable.

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[1] Amer. Jour. Orth. Surg., Oct., 1907, 129.

[2] Willard, Sarcomatous Tumors Simulating Hip Disease, Phila. Med. and Surg. Reporter, Mar. 24, 1894, 424; Momberg's Suprapelvic Constriction, Ann. Surg., 1910, 878.

[3] Young, Univ. of Penna. Med. Bulletin, Apr., 1901.

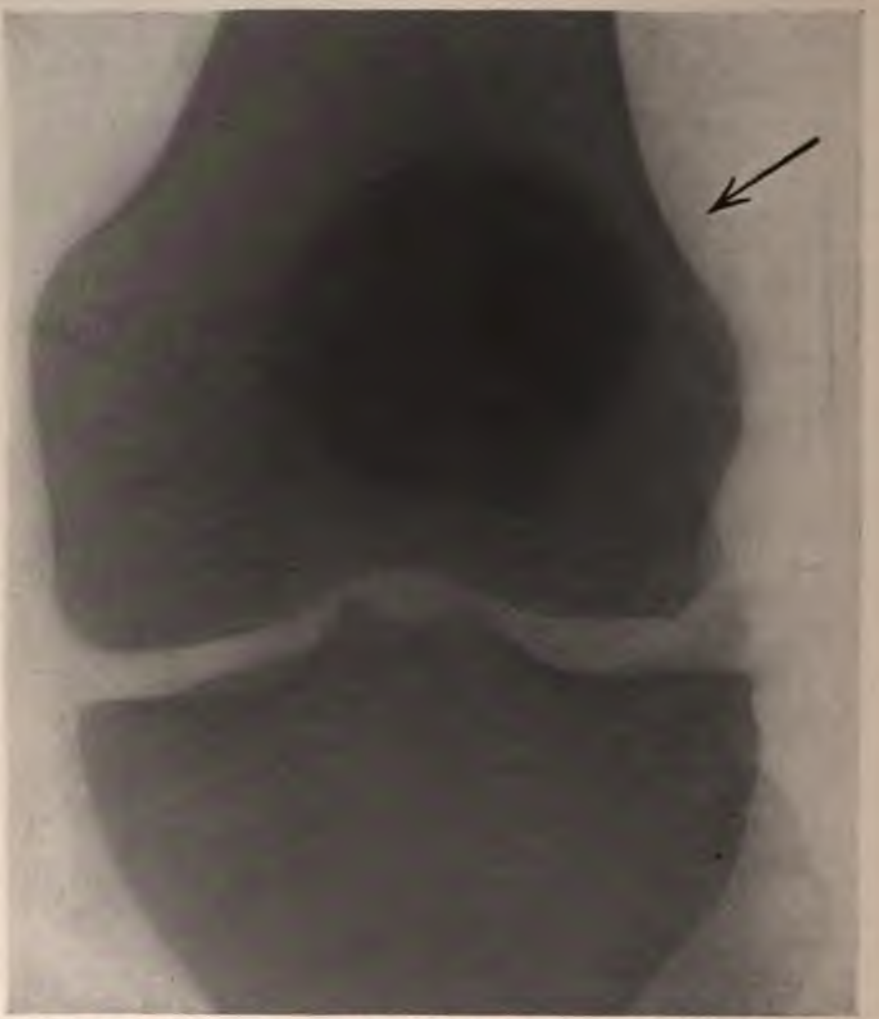

FIG. 531.—Beginning sarcoma in condyles of femur. This mass was not discernible in the glass plate but became apparent in the print. Amputation. (Threlkeld-Edwards.)

FIG. 532.—Amputated sarcoma of tibia and femur.

Wyeth gives an analysis of eighty-three cases[1] that required amputation at the hip joint. Visceral recurrence took place within two years, the lungs being the most common organ secondarily involved. He reports one case alive and well nine years after the operation.

The author's experience is decidedly against the probability of LOCAL recurrence, while visceral involvement almost invariably follows. He has, however, one case living eighteen years after an amputation of the thigh, the lower femur having been so fragile that it crumbled when lifted at the time of operation. Another case, of shoulder-joint amputation, is living and well eight years after operation for humeral sarcoma. Another recent case, after amputation of thigh, died in six months without local involvement (Fig. 532); another case of thigh amputation died with secondary deposits in almost every organ of the body.[2]

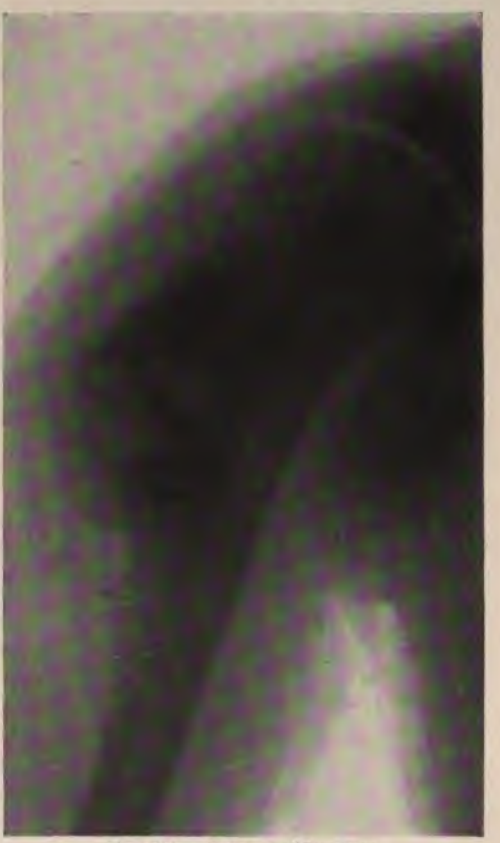

FIG. 533.—Osteoma of humerus.

Treatment. — AMPUTATION, even at the joint above the diseased area, in round- or spindle-celled sarcoma rarely succeeds in preventing return. Resection of the diseased area in the giant-celled variety is more hopeful, and myelogenous sarcoma may be locally completely and safely removed, while the spindle-celled and round-celled sarcomata are almost certain to recur. In many cases considered as cured, a recurrence has taken place after three years. Coley, however, presents forty-four cases free from recurrence from three to thirteen years, by the use of the MIXED TOXINS of bacillus ERYSIPELATOSUS and PRODIGIOSUS.[3] He advises that the treatment be commenced hypodermically with one-fourth to one-tenth of a minim mixed with sterile water, at a point distant from the tumor, later into the tumor itself, but in the latter case the injection should be smaller. Doses may be increased by one-third

[1] Wyeth's Surgery, 2d Edition, 709.

[2] Willard, Sarcoma of Femur, Secondary Deposits in Heart and Spleen, Phila. Med. News, xlii, 54; Bost. Med. and Surg. Jour., 1883, 34.

[3] Coley, Surg. Gyn. and Obstet., Feb., 1908, 129; Ann. of Surg., March, 1907; xlv, 130, 321; Amer. Jour. Med. Sci., March, 1906; Trans. Amer. Surg. Assoc., 1908; Bost. Med. and Surg. Jour., Feb. 6, 1908, 175.

minim until several minims can be used, if the temperature does not rise above 103 to 104 degrees. Patients will not be able to endure the injections more than twice or three times a week. In successful cases, the tumor in two weeks diminishes in size and is less sensitive. Deep injections are less irritating than those made into connective tissue. Local pain may be lessened by adding a sterile solution of cocaine to the toxins. Coley uses the mixed toxins of prodigiosus and erysipelatosus both before and after operation and also in non-operative cases.[1]

FIG. 534.—Osteoma of crest of ilium. Removed by chisel.

Wyeth advises the infection of the amputating wound with pure STREPTOCOCCUS PYOGENES, followed by pure cultures of the STREPTOCOCCUS ERYSIPELATOSUS (Fehleison). He uses the same micro-organisms for inoperable cases[2] and notes the benefit derived in sarcoma from spontaneous attacks of erysipelas, showing the virulent character of this powerful

[1] Coley recommends the fluid prepared by Dr. Martha Tracy at the Women's Hospital, Philadelphia.

[2] Wyeth's Surg., 2d Ed., 710.

great danger in the use of the X-ray before operation is the fact that its application is prolonged until relief by operation is too long delayed.

OSTEOMA.

Exostoses are not uncommon in children. These growths develop at various ages and, though benign, often become painful by pressure upon nerves or by interference in the play of muscles.[1] When situated on the dorsum of the foot or on the os calcis they frequently become crippling (p. 716).[2]

Several varieties are seen in Figs. 533, 534 and 535, taken from the author's cases. Each of these was removed by incision and chiselling and recurrence has not taken place in any instance.

[1] Willard, Osteoma of Tibia, Ann. Surg., xxv, 763.
[2] Ochsner, Ann. of Surg., 1907, xlvi, 608.

CHAPTER XXVI.

PARALYSES.

INFANTILE SPINAL PARALYSIS.

Synonyms: Anterior poliomyelitis; essential paralysis of children; acute atrophic spinal paralysis; teething palsy; myogenic paralysis; acute epidemic myelitis, spinal, bulbar, or encephalic; essentielle Kinderlähmung; Paralysie spinale.

ANTERIOR poliomyelitis is a disease of early life, often resulting in most serious and crippling deformities (Fig. 536). It is a motor paralysis affecting chiefly the lower limbs and is due to hemorrhage or injury in the anterior cornua of the spinal cord. Contraction and atrophy of certain groups of muscles follow (Fig. 537), with distortions of bones but sensation is not affected. It may appear as early as the first month of life but is rare under six months. Between one year and three it is very common.

FIG. 536.—Infantile spinal paralysis of right thigh and leg with external rotation and flexion.

Epidemic Influences. —The occurrence of epidemics of this disease in healthy children in certain localities[1] indicates that the disease, at least in these cases, was due to microorganisms.[2] Such epidemics have been observed in Pennsylvania,[3] New York, Massachusetts,[4] and other States and over forty such outbreaks have been recorded.[5] In New York in 1907, a toxic infectious epidemic of two thousand cases occurred in hot dry weather, with a mortality of 6 to 7 per cent. from paralysis of the respiratory centres in numerous cases.

[1] Willard, Univ. Med. Mag., Phila., vii, 68 and 149, 1894.

[2] Painter, Trans. Amer. Orth. Assoc., 1902, 414; Jour. Amer. Med. Assoc., Jan. 4, 1896; Brackett, Trans. Amer. Orth. Assoc., xi, 132; Taylor, Bost. Med. and Surg. Jour., cxxix, 504.

[3] Report Pennsylvania Commission of Health, 1907, 1908, Dixon.

[4] Lovett, Amer. Jour. Orth. Surg., 1908; Amer. Jour. Med. Sci., May, 1908; Jour. Amer. Med. Assoc., Nov. 14, 1908; Trans. Mass. Med. Soc., June 9, 1908; Amer. Jour. Orth. Surg., 1910.

[5] Starr, Amer. Jour. Med. Assoc., July 11, 1908.

The most reasonable explanation of the specific virus is received through the digesti which toxin penetrates to the central nervou or blood channels.

Autoinfection.—The fact that quently after the digestive disturbances of or other acute exanthemata, would point to s locating itself in the spinal cord with disas nervous irritability of the infant during its with the high temperature of summer an evidenced by cholera infantum, enterocolitis causes to induce autointoxication.

Sitting on the cold damp ground when play of children between two and four years

Fig. 537.—Paralysis of left limb with thigh contracted to right angle with body.

cause of ac occasionall disease m children, r

Con CONTAGIO tive in a f causal infl been epid

Patho tologic in of the spinal fluid drawn by spinal punc of bacilli,[2] but none sufficiently distinctive

For diagnostic purposes the cerebrosp spinal puncture[3] (Fig. 19, p. 29). The m The patient may sit stooping forward, or lie bent forward to enlarge the posterior interv from the top of the crests of the ilia will cros The needles should be from 4 to 10 centime lette; or an ordinary hypodermic needle will manometer tube and sterile test-tubes are re enter beyond the subarachnoid space lest punctured. In children the depth is from 2 fluid may be withdrawn.[4] If Flexner's n useful, it may be injected into the spinal can

The experiments of Flexner may lead this most stubborn and disabling paralysis.[5] with virus from the cord and lymph-glands

[1] Amer. Jour. Orth. Surg., 1910.

[2] Jour. Amer. Med. Assoc., Jan. 25, 1908, 281; Amer. Med. Assoc., Dec. 21, 1907, 2082.

[3] Jour. Amer. Med. Assoc., Dec. 7, 1907, p. 196

[4] Mt. Sinai Hos. Report, N. Y., vol. v, 117; Quin Amer. Jour. Med. Sci., Oct., 1900.

[5] Jour. Amer. Med. Assoc., Jan. 1, 45, Feb. 12, Dec. 4 and 18, 1909; Jour. Exper. Med., 1910, 227;

poliomyelitis, he has succeeded not only in producing the paralysis but also in being able to transmit it through a series of monkeys. Up to the present time he has been unable by inoculation to produce the paralysis in rabbits, horses, dogs or other animals.

The bacillus or its toxins, probably anaërobic, must reach the spinal cord through the one anterior or two posterior spinal arteries. The anterior spinal are branches of the vertebral artery within the skull and descend along the ventral surface of the cord in front of the anterior median fissure. The anterior cornua are supplied by the anterior spinal. The distribution of the motor root in the anterior horn of the spinal cord has been definitely studied by many careful observers.[1]

FIG. 538.—Paralysed limbs supported by the hands.

The first process in the paralysis is hyperemia, then extravasation, hyperplasia, secondary degeneration and atrophy of neuroglia cells with fibrosis, — an inflammation of the anterior cornu. The anterior cornu of the cord being the most vascular portion may determine the localization of the poison, just as the increased vascularity of the epiphysis in bones invites infection of tuberculous organisms. Spiller and others have demonstrated that the inflammatory initial hemorrhage or infection is in the gray matter of the anterior cornu and in the large multipolar cells, with secondary cell degeneration and atrophy. The fibrillar structure of muscles supplied by the injured peripheral nerves is replaced by fat globules, with atrophy of fibres, contraction of opposing muscles and distortion of bones and joints. Bone atrophy and deformity follow later. Certain cord cells are damaged but recover, others are destroyed, explaining the partial recovery that takes place in certain muscles while others permanently atrophy.

Symptoms.—The orthopaedic surgeon, unfortunately, is rarely called until valuable time has been lost as regards the most important element

[1] Allen, Univ. Penna. Med. Bulletin, Nov., 1907, 202; Cadwallader, Contrib. Labor. Neuropathol., Univ. of Pa., 1908.

in treatment, *i.e.*, the prevention of deformit
usually seen by the family physician, and, as

FIG. 539.—Note the development of the chest and shoulders from use of crutches as compared with the small pelvis and feeble lower limbs.

In acute hemorrhagic cases, a child in
restless night, will be found in the morning
the cases of slower development followin

cholera infantum, there may be delirium, convulsions and unconsciousness preceding the paralysis. The early muscular tenderness often results in the false diagnosis of muscular rheumatism. In meningitic cases, the paralysis if slight may not be discovered until the child attempts to walk.

After a stationary stage of a few weeks, improvement commences and continues in certain muscles for months until absorption of meningeal effusion has taken place. Then follows the permanent stage of atrophy of the injured muscles and contractions or bone deformities. Reflexes will be abolished and electrical reactions to faradic currents diminished or lost. Circulatory and nutritional changes render the legs cold and blue, but sensation remains. The feeble legs require the assistance of the arms in many movements (Fig. 538), and the disparity of development in chest and lower extremities becomes marked (Fig. 539). In flail legs, abdominal and pelvic muscles are called into action as substitutes for the paralyzed ones.

Fig. 541.—Atrophied shoulder joint in a case of arm paralysis.

Deformities. — Deformities result from (1) degeneration of muscles; (2) atrophy; (3) contraction; (4) distortion of bones and joints from efforts at locomotion; (5) deficient bone growth. Bone shortening and atrophy are the results of the general impaired nutrition which is so noticeable in the muscles. Muscle and bone atrophy of one thigh and leg are often in great contrast to the compensatory development of the opposite limb (Fig. 540).

In the arm the most persistent paralysis, that of the circumflex, affects the deltoid or supra- and infraspinatus, the biceps and supinators. Great relaxation of the shoulder ligaments permitting easy subluxation is often noticed (Fig. 541).

Shortening of the leg may amount to two or four inches and with the tilting of pelvis, especially if the trunk muscles are involved, sometimes results in fixed lateral curvature of the spine (Fig. 174, p. 253).

Constant sitting upon the floor from infancy, with flail or dangling legs in false positions (Figs. 548, 551), will distort the heads and necks of the femurs until they are twisted as in coxa vara, or straightened as in coxa valga (Fig. 542), or the ligaments may become so stretched that partial or complete dislocation is possible. Contractions of the tensor vaginæ femoris, the rectus and the fascia lata, produce marked flexion, tilting of the pelvis and lordosis. The long-continued pull of the psoas in

flail legs in its effort to compensate for lack
produces elongation of the lesser trochanter (

Deformities at the knee include flexion
from paralysis of the anterior thigh mus
and in-knee.

The most common deformities at the ank
(Fig. 545) from paralysis of the peroneals an
contraction of calf muscles and tibials; or equ

FIG. 542.—Paralytic distortion of neck of femur resembling
weight of body.

when the tendo-Achillis alone is shortened;
sis of the tibials and contraction of calf m
neovalgus (Fig. 547) from paralysis of cal
caneocavus, when the os calcis is in straig
sole is contracted (Hollow-foot, p. 695).

In many cases the distortions occur at
and locomotion is secured only with crutch
impossible. Fig. 548 shows a boy who had
fourteen years. After multiple tenotomies
muscular development, his condition two y

and five years later he was able, with the assistance of apparatus, to walk five or six miles.

Differential Diagnosis.—For the proper inspection and diagnosis of the late deformities and the method of locomotion, it is absolutely necessary that the child be examined naked.

CEREBRAL SPASTIC PALSY is marked by incoördinate muscular movements, sometimes choreic or athetoid, indicating lack of central control,

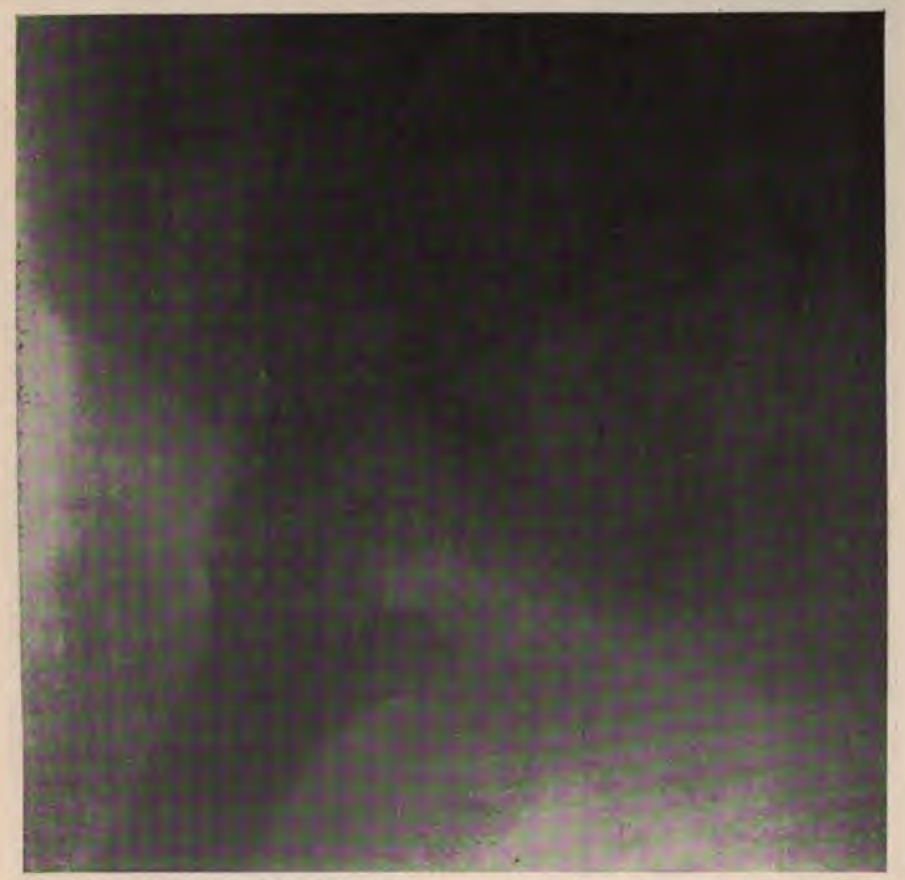

FIG. 543.—Elongation of trochanter minor from action of psoas muscle in a case where all the thigh muscles were paralyzed and flexion was accomplished by the contraction of the psoas.

while in infantile spinal paralysis contraction is feeble or absent. In the former the limb is of full size and muscles rigid; in the latter, atrophied. Reflexes are exaggerated in the former; feeble or absent in the latter. Intelligence is impaired in the former in degree varying from slight defectiveness to full idiocy; normal in the latter. Paralysis, hemiplegic or paraplegic or diplegic, is present in the former; in the latter, one leg is most frequently affected.

CEREBRAL PARALYSIS from hemorrhage after whooping-cough or meningitis is usually hemiplegic, and sometimes involves the face. Tendon

reflexes are increased, muscle atrophy is not as marked and more or less spasticity is liable to follow. In cerebral palsy, electrical reactions are practically normal; in infantile spinal palsy they are lost in the permanently atrophied muscles.

In TRANSVERSE MYELITIS and SPASTIC SPINAL PARAPLEGIA sensation and motion are both lost.

CEREBROSPINAL MENINGITIS. — During the acute febrile stage the symptoms of the two diseases as to convulsions, stupor, etc., may be quite similar, but there is no opisthotonos in anterior poliomyelitis. Spinal puncture will show the bacillus. The paralysis, usually hemiplegic, will generally recover without atrophy.

PARAPLEGIA FROM SPINAL CARIES. — Kyphosis, increased reflexes and bilateral paralysis will be present.

FIG. 544. — Paralytic back-knee, posterior ligaments stretched and bones deformed.

FIG. 545. — Infantile spinal paralysis resulting in talipes valgus in right foot, equinovarus in left, with back-knee.

RHEUMATISM. — Even in the early stages no symptoms warranting such a diagnosis will be present save muscular tenderness; all other symptoms of rheumatism will be absent. In the later stages, the paralytic symptoms are positively distinctive.

JOINT INFLAMMATIONS, other than tuberculous, have sufficiently definite local symptoms.

DIPHTHERITIC PARALYSIS. — As even a slight infection may be followed by paralysis, the history should be investigated. The paralysis is usually slowly progressive, not sudden in onset. Atrophy is not marked. Infantile spinal paralysis may, however, occur in the course of or following diphtheria.

NEURITIS.—Neuritis is not common in children. The initial stage is similar to that of infantile spinal paralysis as regards muscle tenderness and pain, but the sensitiveness is more persistent, and sensation and motion are both altered.

RICKETS.—In the early stages of rickets, general tenderness of the bones is found with indisposition to move the legs rather than a paralysis, and reflexes are normal. Pseudoparalysis can be detected by pinching or pricking.

OBSTETRIC PARALYSIS—Birth Palsy.—The history of paralysis from birth and the infrequency of arm paralysis alone in infantile spinal paralysis are distinctive diagnostic symptoms.

PARALYSIS FROM NERVE INJURY.—This variety has a definite history, and motion and sensation are both affected.

PSEUDOHYPERTROPHIC PARALYSIS and PROGRESSIVE MUSCULAR ATROPHY only occasionally occur in children (p. 660).

FIG. 546.—Acquired talipes equinus from anterior poliomyelitis.

TUBERCULOUS HIP DISEASE.—The existence of a limp will call attention to tenderness about the hip; examination of the naked body shows rigidity of the periarticular muscles and flexion, eversion and abduction of the thigh. In infantile spinal palsy there will be relaxation and loss of power with deformities; later, thickening and fixation in hip disease will be positive (p. 466).

CONGENITAL MALFORMATION AT HIP.—As this deformity is not discovered until the child begins to walk, a thorough examination of the nude body may be needed to determine the cause of limp, especially when a slight paralysis has been overlooked. The shortening of the thigh, high position of the trochanter, mobility of the malformed head, nonatrophy of the muscles and normal electrical reactions will be distinctive (p. 725). In subluxation of the hip from infantile spinal paralysis, atrophy of muscles will be marked.

FIG. 547.—Paralytic talipes calcaneus in left foot, calcaneovalgus in right.

Prognosis.—The prognosis will be an important matter both to parents and surgeon. The paralysis seldom increases after ten days. Immediate death except in epidemics is rare and many cases live to old age. Certain groups of muscles will recover power, others will permanently atrophy. Improvement may be confidently expected at the end of two months and this improvement, under proper treatment, will continue for one or two years under the stimulus of properly regulated locomotion, massage and electricity. Short-

ening of the limb is to be expected from de
muscle atrophy. Deformities can be largel
under the direction of a careful orthopaed

The reaction of the muscles to electr
element as regards prognosis and diagnosis.
show diminished faradic irritability even aft
two weeks response is permanently lost.
hibit contractility, gain may be expected
massage and electricity should not be ab
tary or electrical contraction is present. M
frequently can be restored in an entire ar
a large extent in the leg. Under a galvani
muscles will respond more slowly than nor
permanently paralyzed muscles the normal

FIG. 548.—Paralytic boy of fourteen, who had never walked (

formula will be reversed and the closure of
tive anodal pole will give a greater contract
negative cathodal closure, thus giving the re
degeneration. A muscle that fails to respond
faradic or galvanic stimulation at the en
months is probably permanently disabled.
reaction of degeneration is assured by the
expert and if only AN CL C electrical reactio
voluntary contractility is lessened; but stret
strain is removed. Efforts for the restoratio
be abandoned as long as gain is noticeable.[1]
tion and deformity, the proper treatment
a crippled sufferer condemned through igno
less existence in chair or bed. By judicious,
procedures, followed by mechanical suppo
muscular exercises, the author has often

[1] Sachs, Amer. Jour. Orth. Sur

walking, even many miles, after being helpless on the floor for ten or more years. Fig. 550 shows the result of the application of surgery in the case of a totally useless pair of legs seen in Fig. 551. Walking with the aid of braces subsequently became decidedly comfortable. To watch the development of hope and ambition in the faces of these unfortunates, as they realize that they are no longer helpless dependents, is great reward to the surgeon for the long months of unceasing care necessary to accomplish this improvement. The gain in physical, mental and moral conditions is something beyond description.

FIG. 550.—After tenotomies at hips, knees and ankles, followed by muscular exercises, patient seen in Fig. 551 could stand erect, and could walk with the aid of apparatus after one year's treatment.

FIG. 551.—Lower limbs totally helpless for twelve years (see Fig. 550).

Treatment.—1. Restoration of function.
   (*a*) Massage and electricity.
   (*b*) Gymnastic and voluntary muscular exercises.
2. Prevention of deformity.
   (*a*) Splints.
   (*b*) Mechanical appliances and apparatus.
3. Operative treatment.

1. RESTORATION OF FUNCTION.—In the febrile initial stage every discoverable cause should be investigated and removed. Primarily the alimentary canal must be cleansed to relieve autoinfection. Dental, genital, rectal, gastric and any source of reflex irritation should be corrected. The condition of an infant's gums especially demands attention.

An acute hematogenous myelitis requires perfect rest in the *prone* position with dry cups or Paquelin cautery to the spine and ergot and bromides internally. No strychnia is given until much later in the disease.

The only medicines later that will assist in absorption will be iodine, arsenic and mercury, in very minute doses, long continued.

(*a*) Massage.—Gentle oil massage t
commenced as soon AS MUSCLE TENDERNES
first is to be applied for a few minutes, ther
rest. Systematic stroking, kneading, fri
continued for months or years if there
from an electric pad or bulb or other m
is in bed will give much comfort. Later,
limb will require extra warm clothing t
will always be poor.

Increased blood supply and nutrition
boot of former days, or by foot cupping a

Electricity.—The chief value of
stimulate nutrition and induce muscular
temporarily of voluntary motion. The curr

FIG. 552.—Machine for vibratile friction massage, run by elect
and spine can be treate

strong to give pain. Preferably mild fara
response is secured, galvanism is to be tried.
response to either form of current, both mas
continued, often for more than a year. To t
correction and manipulation of any developin

(*b*) Gymnastic and Voluntary
—Voluntary muscular exercises are especia
time and means permit, mechanical vibrat
movements, as provided in a well-equipped
152, p. 235), are of the greatest advantage in s
and contractility to the weakened fibres. Th
by these methods even in later years and espe

[1] Phila. Med. Bulletin, Dec

ening of deformities, is marvellous. The Schulthess and Zander machines and Swedish movements are very beneficial.[1]

A vibratory machine run by an electric motor is seen in Fig. 552. Such a machine saves the strength of the instructor, and permits two patients to be treated at the same time. Arms, hands, legs, feet and back can receive vibratory massage by the many different attachments connected to the appliance. Other machines for developing arm and leg muscles are given on p. 235.

At the University Hospital Gymnasium selections are made from the prescription itemized on p. 268 as applicable to the individual case.

For young children, where the helpful element of play must be secured to induce voluntary muscular movements in the limbs, no better appliance than a spring swing (Fig. 553) can be found. This consists of a seat or chair with raised rail in which the child can be held safely by straps and be amused for hours. This chair is suspended from the ceiling by springs so arranged that the feet will just touch the floor. In a very short time the child will discover that he can propel himself by pushing with his feet; apparently useless muscles will soon develop and walking will be commenced. Locomotion can be stimulated also by the use of a "baby-tender" or of a wheeled crutch (Fig. 554), or by support in leather jacket in an overhead suspension trolley (Fig. 152, p. 235). The various vibratory and voluntary foot machines are also very useful (p. 268). A hickory springboard, supported at either end, will be found one of the most useful as well as the most popular of nursery paraphernalia for paralyzed or for normal children.

FIG. 553.—Chair suspended from ceiling, and with three springs, permitting a paralytic patient to reach the floor with feet. Excellent for young paralytics.

For paralyzed arms, a valuable developer of muscles in children and a cheap and popular amusement may be furnished by an ordinary rope and board swing. From the top supporting beam of this swing, wooden arms one foot in length are nailed at right angles. From the ends of these arms

[1] For general and special effect of muscular development see Young, Physical Development of Children, Keating's Cyclopædia, Diseases of Children, vol. iv; Mitchell and Solis-Cohen, Physical Development.

are passed strong cords, to be attached to hollow wooden hand-pieces sliding up and down upon the ropes. By pulling upon these hand-pieces, the child swings himself and daily gains arm power (Fig. 555).

A stationary bicycle with pedals to which the feet can be strapped affords a pleasing therapeutic machine (Fig. 153, p. 236). This is at first propelled by an electric or water motor, to be followed by voluntary leg power as soon as muscles strengthen. Perambulators and tricycles also are used. A more expensive but helpful machine, on which both arms and legs are developed as the propelling power, is a miniature merry-go-round for out-of-door use.

2. Prevention of Deformities.—(*a*) Splints.—Measures to prevent the to-be-expected deformities should begin while the patient is in bed. Judson recommends the recumbent position for more than a year during the period of recession, to prevent deformities because these defor-

Fig. 554.—Crutches erected on baby-coach frame and wheels. Excellent for assisting locomotion in feeble paralytics.

mities occur eight times as frequently in the lower as in the upper limbs. The common occurrence of foot-drop demands that the weight of the bed-clothing and the influence of gravity shall not stretch the weakened anterior tibial muscles at the ankle. A bed hoop or cradle and a light felt, leather or metal right-angled splint will maintain the position of the foot and permit removal for massage.

(*b*) Mechanical Appliances and Apparatus.—Mechanical treatment is most valuable as a preventive of deformity both before and after operative relief, but it is cruel to attempt for weeks or months to stretch a strong, contractured muscle and tendon by braces, when a simple tenotomy will easily and painlessly remedy the distortion in a few minutes and will improve, not lessen, contractile power. Objection is often made to braces that they produce atrophy of the limb, the fact being overlooked that atrophy is a constant result of the disease itself. Properly constructed apparatus should not interfere with circulation, and its employment will

often prevent great distortion of bones, ligaments and muscles. Every brace should be carefully adjusted by the surgeon himself with bending irons (Figs. 556 and 610, p. 673). As soon as walking is commenced, ankle, knee and hip must be closely watched, weakened muscles massaged, contracting ones manipulated and stretched, deviations at the ankle prevented by equinus or calcaneus stop-joints, inward or outward varic or valgic tendencies supported by uprights, pads, etc., and increasing back-knee controlled by a stop-joint. Elastic (Fig. 557) or spring assistance to weakened muscles is better than fixed support, as every encouragement should be given to voluntary action and to equalization of muscle balance.

No definite outline can be formulated for the construction of apparatus except that it should be individually and mechanically planned by the surgeon after a careful inspection of the locomotion of the nude child, after which he can decide as to the muscles that need assistance, the ones that are liable to contract, and the distortions of bone, ligaments and joints that will probably be produced by faulty weight-bearing. Nothing should be left to the instrument maker except the carrying out of the mechanical portion of the surgeon's plan.

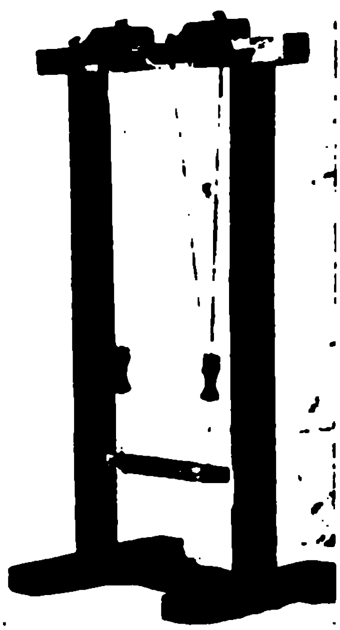

Fig. [illegible] M[illegible]

Inequality of the length of the limbs is corrected by cork elevation to prevent lateral curvature of the spine and pelvic tilting. The chief advantage of apparatus is in post-operative support. There are few limbs, even of flail legs from the hips, that cannot, after proper surgical care, and a wisely constructed apparatus, be made to take some part in securing locomotion (Fig. 558).

Trolley suspension (Fig. 152, p. 235) or wheel crutch progression (Fig. 560) will stimulate muscle action[1] and hundreds of so-called hopeless cases can be gradually advanced from chairs (Fig. 559) to crutches (Fig. 382, p. 436), from crutches to canes and from canes to nearly normal walking.

For complete paralysis of the quadriceps, uprights with lock-joints at the knee may be temporarily employed with a broad leather pad buckling across the front of the knee. The very wide well-fitting padded and covered steel band behind the upper region of the thigh should have its upper edge bent slightly outward to avoid injury by friction to the skin, but not flare so greatly as to cut the clothing. The latter annoyance can be avoided by using in place of steel a broad sole leather thigh band, with only a light steel posterior arch near the knee. A knee unable to temporarily bear weight may be supported by a ring drop-lock (Fig. 561) or by a Cowgill joint[2] or by two anterior steel arms with strong interposed

[1] Willard and Hinsdale, Anterior Poliomyelitis, Medical News, 1894.
[2] Bradford and Lovett, 475, 476, 477.

elastic, or by a posterior spring. These
the clothing, to avoid a straight leg when s

Stretching of a contracted knee by
mechanical device (Fig. 485, p. 524) is pain
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good crutch (Fig. 473, p. 515) if a bandage
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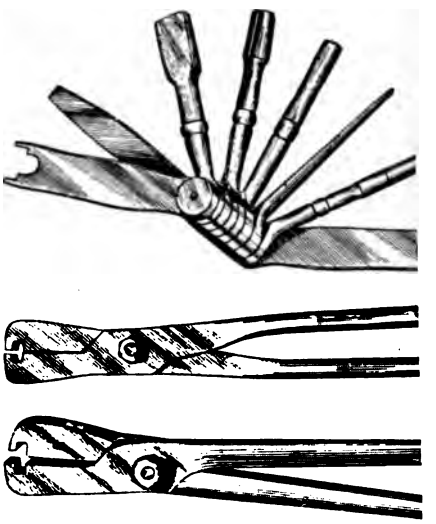

FIG. 556.—Bending irons for adjustment of steel apparat

on his knees. A higher body support may
are also paralyzed (Fig. 562); or stiff corse
buckled leather band passing from one upr
in lessening pressure upon either a varus or
broad T-strap can be used. Knee-caps for
knees are best made of large leather pads (F

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the straight position. A feeble back-knee
prevented by a four-inch posterior trough of

Paralysis of trunk muscles will require leather or steel supports, as in spinal diseases (Fig. 219, p. 279).

In paralysis of the arm, support of the elbow by a sling will lessen the stretching of shoulder ligaments and arm muscles.

For paralysis of the shoulder with permanent loss of power from either anterior poliomyelitis or from birth palsy with overstretching of the deltoid, Silver[1] recommends fixation of the arm for six or more months, with supination of the wrist, flexion of elbow, outward rotation, abduction and elevation of the humerus. Jones recommends removing a diamond shaped flap of skin and the suturing of the forearm to the arm in the flexed position, to prevent stretching of brachialis and biceps muscles with consequent relaxation and paralysis.

FIG. 537.—Apparatus with elastic supplementary muscles on left leg to assist the tibiale in valgus; right, to assist the peroneals.

FIG. 538.—Apparatus for support of body and limbs in extreme infantile spinal paralysis after operations.

In wrist-drop, elastic extension straps may be attached to leather arm and hand bands or a supporting apparatus can be worn (Fig. 510, p. 571).

While manipulative and mechanical treatment is of great importance in the prevention of deformities, yet unfortunately, the orthopaedic surgeon has most frequently to deal with the neglected and extreme distortions produced by weight-bearing upon hip, knee and ankle. The results of skillful operative measures are so demonstrable and effective that they should never be denied to any sufferers who have reasonably strong limbs. As discussed under prognosis (p. 615), it is inhuman to condemn any person

[1] Amer. Jour. Orth. Surg., Nov., 1908, 239, 314.

elastic, or by a posterior spring. These joints can be unlocked beneath the clothing, to avoid a straight leg when sitting.

Stretching of a contracted knee by Stromeyer screw splint or other mechanical device (Fig. 485, p. 524) is painful and useless until after tenotomy of the hamstrings. A Thomas caliper walking knee splint makes a good crutch (Fig. 473, p. 515) if a bandage is applied in front of the knee and behind the calf, and if muscles are sufficiently strong.

A temporary locking and unlocking device for use at the hip after operation is a leather body and thigh support that can be attached to the uprights extending from the shoe, or a convalescent hip splint may be used (Fig. 429, p. 480). The steel pelvic portion of an apparatus should always be removed as soon as the child is able to support the pelvis while standing

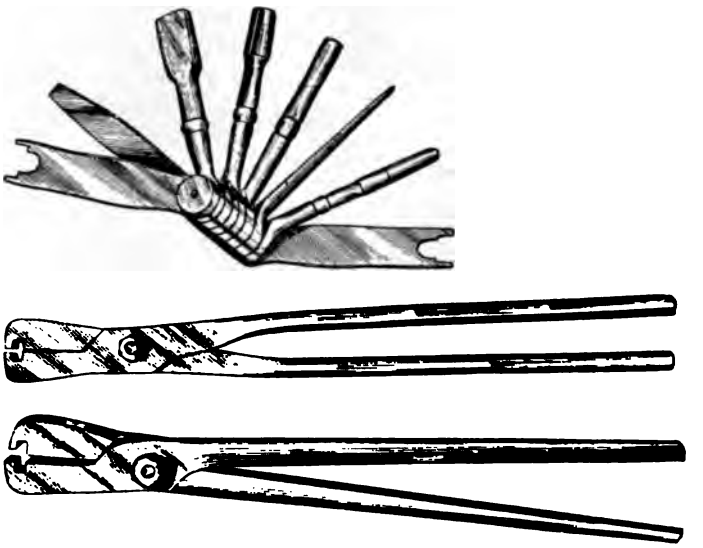

FIG. 556.—Bending irons for adjustment of steel apparatus, also pocket instruments. (Young.)

on his knees. A higher body support may be added when trunk muscles are also paralyzed (Fig. 562); or stiff corsets may be used. A laced or buckled leather band passing from one upright around the leg will assist in lessening pressure upon either a varus or valgic pad at the ankle, or a broad T-strap can be used. Knee-caps for anterior support of weakened knees are best made of large leather pads (Fig. 563).

ACQUIRED BACK-KNEE OR GENU RECURVATUM is much more common as the result of infantile spinal paralysis than of rickets. When it has been neglected, especially when the hamstring muscles are greatly relaxed, the extreme stretching of the posterior ligaments of the knee-joint renders the disability great. No operation save that of arthrodesis promises hope of relief, but a stop-joint with shoulder will prevent the knee from extending beyond the normal line, which normal line is five degrees of flexion from the straight position. A feeble back-knee can also be supported and prevented by a four-inch posterior trough of leather.

FIG. 360.—Wheeled crutch for support of body in extreme paralysis with distortions and almost totally helpless legs.

FIG. 361.—Apparatus for paralysis with locking and unlocking ring drop catch at knee.

FIG. 362.—Apparatus with pelvic band and lateral pads at knee and ankle.

to a hopeless existence when a few moments of surgical help and a few months of patient after-treatment will readily result in a self-supporting and mentally elevated individual.[1]

The object of surgical treatment is to bring feet, knees and hips into such line of weight-bearing that either with or without mechanical support, walking will be possible. In all severe cases of deformity, surgical treatment should precede mechanical. Surgery can do far more in a few minutes to correct the deformities following anterior poliomyelitis than can be

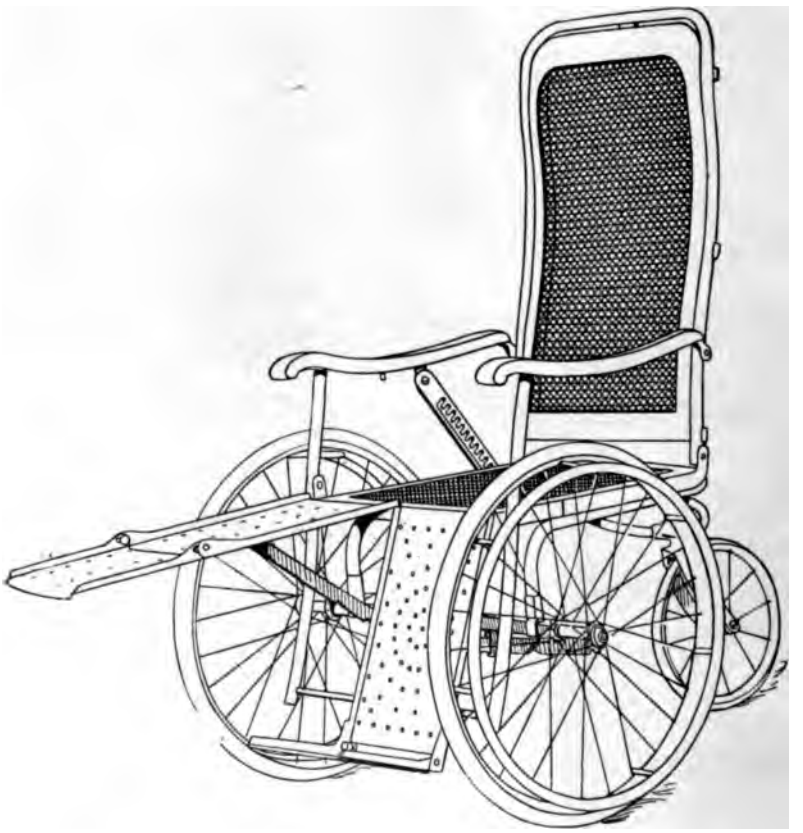

FIG. 559.—Wheeled chair with lower portion divided to secure straight position for one leg without interfering with the other. (Bernstein.)

accomplished by months of painful mechanical appliances. No one should be permitted to pass a crippled and handicapped life of suffering until a thorough examination of possible powers of locomotion has been carefully studied, with body entirely bare. Success depends upon the judgment and

[1] Willard, Infantile Spinal and Cerebral Spastic Paralyses, Articles in Bryant and Buck's Amer. System Surg., vol. 2, p. 487; Trans. Amer. Orth. Assoc., iv, 382, vii, 326; Amer. Jour. Med. Sci., May, 1891, 470; Tenth International Med. Congress, Berlin, 1890, Band. iii; Trans. Penna. State Med. Soc., xxvii, 361; Arch. Ped., xi, 665; N. Y. State Med. Rep., 1894, 226; Pediatrics, i, 193; Phila. Med. and Surg. Rep., lxxv, 491; Phila. Med. News, Dec. 19, 1891, 697; Internat. Clinics, 1893, iii, 207.

contraction of the muscles and fascia below the anterior superior spinous process of the ilium or from abduction (Fig. 537, p. 608).

Myotomy of the tensor vaginæ femoris, of the long head of the rectus femoris, of the sartorius and of the fascia can be safely done subcutaneously. The skin is drawn far inward before the puncture is made, in order to remove the wound after its retraction as far as possible from the urinary organs. The tenotome must be strong and have a long cutting face (Fig. 584, *E*). The only danger encountered will be the anterior crural nerve which lies to the outer side of the femoral artery and vein, where its situation is masked by the dense fascial contraction. For this reason it is sometimes better to divide the muscles by an open oblique or inverted V-shaped incision, to reach any contracted tissue. When the insertion of the psoas or the rotators of the hip require division, the open operation is of course necessary. In one instance the author successfully divided a contracted

FIG. 564.—Locomotion possible only on all fours. Photographed by the Muybridge process by a series of electrically operated cameras. Read from left upper corner to lower right-hand corner (see Fig. 565).

psoas intraperitoneally during an abdominal section for tubal tuberculous disease. The insertion of the iliopsoas upon the lesser trochanter may be reached from behind, and the trochanter and muscle separated by chisel and knife.[1] After myotomy, powerful stretching in the direction of extension must be made, the crests of the ilia being fixed by an assistant or by flexing the opposite leg upon the abdomen or by turning the patient upon his face. Care must be taken not to strain the sacro-iliac ligaments. As these hip myotomies are nearly always done in connection with operations upon both knee and ankle,[2] the heavy plaster-of-Paris casts are usually sufficient to retain the thigh in straight line. Weight and pulley extension may sometimes be employed to advantage. The wound left below the anterior superior spinous process after section and stretching is closed by catgut sutures and covered with aristolated cotton and collodion. The blank space is obliterated by a sterile gauze pad and firm spica bandage.

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[1] Anasoletti, Amer. Jour. Orth. Surg., Aug., 1909, 147.

[2] Willard and Hinsdale, Anterior Poliomyelitis; Mütter Lecture, Phila. Coll. Phys., 1893.

operative skill of the surgeon, the subsequent care, and the protection and education of the muscles.[1]

3. **Operative Treatment.**—(1) Tenotomies and fasciotomies; (2) myotomy; (3) forcible correction under ether, manual and instrumental; (4) open incision; (5) tarsectomy; (6) excision; (7) osteotomy; (8) arthrodesis; (9) bone lengthening; (10) tendon shortening; (11) tendon transplantation; (12) nerve anastomosis.

(1) TENOTOMY.—Subcutaneous tenotomy was perfected by Stromeyer, adopted in England by the enthusiasm of Little and introduced into the United States by Mason and Detmold. Little, a victim of acquired talipes equinovarus from anterior poliomyelitis, submitted himself to the operation when an adult and from his efforts has arisen the Royal Orthopaedic Hospital.

FIG. 563.—Apparatus for paralysis, with pelvic band, knee-caps and ankle pads.

The technic of (1) TENOTOMIES and FASCIOTOMIES, (2) MYOTOMIES, (3) FORCIBLE CORRECTION, (4) OPEN INCISION and (5) TARSECTOMY for acquired deformities of the foot and ankle is similar to the methods described under Talipes, and may be consulted on pp. 674–681.

When simple tenotomy is required, local anesthesia may be employed (p. 21), especially if acetone is found in the urine. In the majority of cases forcible correction will also be necessary and a general anesthetic is desirable especially in young children. Nitrous oxide gas is excellent.

Forcible correction while under the influence of the anesthetic is more humane and speedy than when accomplished by mechanical measures.

Contractions at the knee can be corrected by manual force combined with tenotomy of the hamstring tendons. The semimembranosus and semitendinosus are tenotomized subcutaneously, but the biceps should be divided by OPEN incision, as the peroneal nerve lies close to the popliteal side (Fig. 480, p. 520). In old cases, the contracted popliteal fascia will also require division, after which slowly applied stretching force will bring the knee into position, provided the bones have not been too long deformed. Too rapid stretching may tear the popliteal vessels. Care should be taken not to displace the tibia backward, an accident that is more likely to occur if powerful instrumental leverage is applied. The wound over the biceps is closed with catgut and dressed aseptically. The knee, well padded, should be fixed for six weeks with gypsum bandage extending from perineum to toes, as the ankle nearly always requires operation at the same time.

The chief permanent deformities at the hip, aside from the distortion of the femoral neck (which may even require osteotomy), occurs from flexion

[1] Willard, Anterior Poliomyelitis, Univ. Med. Mag., Phila., 1894, vii [illegible] 9.

opened in front or behind or from both sides. The cartilage from tibia and fibula and astragalus is shaved off with narrow chisel or knife, the astragalus being partially disarticulated. Fixation is more certain if a layer of bone is also removed. The ligaments are then stitched with chromicized gut. If valgus coexists with calcaneus, the astragaloscaphoid and calcaneo-cuboid or calcaneo-astragaloid joints should be resected by the excision of a wedge with apex upward and inward, and when combined with transplantation of active tendons and shortening of weakened ones, great benefit will often result. The fibula may be osteotomized at the upper level of the joint and the lower fragment bent inward to grasp the astragalus and narrow the joint.[1] The astragalus is sometimes fixed to the tibia by ivory screw with removable head (p. 335). The wound is closed with catgut and over an aseptic dressing a firm plaster-of-Paris cast is applied for eight weeks, with foot placed at a slightly obtuse angle, after which the patient will walk upon the cast for a month. A stiff-joint brace is worn for a year until consolidation is complete, after which it can be abandoned.

Fig. [illegible]. Result of transplantation of [illegible] and arthrodesis.

Arthrodesis at the KNEE is not as certain as excision to secure ankylosis (p. 519) and resection is the preferable operation, especially in backward displacement. Back-knee (genu recurvatum), however, may be thus straightened (Fig. 544, p. 614). The joint is laid freely open in front, and cartilage and thin layer of bone removed from femur, tibia and patella. The tendon and capsule is stitched and the joint placed in gypsum for months. A supporting apparatus should be worn for a year or more.

Arthrodesis at the HIP will prove but of little service unless the limb is fairly strong.

The operation is of use at the SHOULDER when relaxation of ligament is great and subluxation frequent. It should be accompanied by shortening, stitching of the ligament and muscle transference. At the ELBOW arthrodesis is not indicated. At the WRIST it is sometimes advisable for cosmetic purposes if combined with tendon transplantation.

9. BONE LENGTHENING.—Magnuson[2] has demonstrated the practicability of lengthening bones whose growth has been retarded by the atrophic process of diminished nutrition. The bone is split in a Z manner, elongated and fixed by ivory screws, easily inserted by a special tap with the same thread. These screws are cut off level with the periosteum and become a part of the bone without irritation (p. 335).

10. TENDON SHORTENING AND LENGTHENING. When a muscle has been permanently stretched from weakness or paralysis, its tendon may be shortened with advantage after tenotomy of the contracted opposing muscles. The most frequent necessity is found at the tendo-Achillis in

[1] Goldthwait, Amer. Jour. Orth. Surg., Jan., 1908, 271.
[2] Magnuson, Univ. of Penna. Med. Bull., May, 1908.

Fig. 564 shows a patient who was unable to progress except on hands and feet, but after multiple tenotomies at hips, knees and ankles could walk a considerable distance with the assistance of apparatus (Fig. 565). The figure depicts by the Muybridge method her method of locomotion, reading from the upper left-hand corner to the lower right corner. These photographs were taken by a series of electrical appliances attached to a number of cameras and illustrate accurately her manner of progression.[1]

Fig. 565.—Same patient as Fig. 564 after operations.

(6) Excision, (7) osteotomy and osteoclasis are occasionally required for paralytic deformities.[2] Their technic is elsewhere described (p. 299).

In great bone distortion excision may be necessary. In back-knee, arthrodesis with tendon transplantation (p. 630) may be required, if a stop-joint apparatus fails to control.

In extreme knock-knee subsequent osteotomy of the femur above the condyle will correct distortion, but after the above operations, it will sometimes be found that the in-knee has been largely due to inversion at the hip.

(8) Arthrodesis—Induced Ankylosis. — This operation consists in the removal of the cartilage and a section of bone from the surfaces of an articulation to induce ankylosis. It is not advisable in children under eight years of age, and never applicable until massage, electricity and gymnastic exercises have been thoroughly tried and proven ineffective. Weak muscles apparently paralyzed sometimes recover tone after simple surgical procedures which relieve the stretched muscles and so correct deformity that voluntary locomotion is possible. In young children bone growth may be interrupted by this operation. It is useful in cases of flail joint where all muscular power has been lost, and the patient desires to be rid of the life-long use of unsatisfactory apparatus.[3]

Fig. 566. — Paralytic calcaneovalgus. Note straight position of os calcis in line with leg.

It is an operation of special advantage in extensive calcaneovalgus (Fig. 566). A result is shown in Fig. 567. The ankle-joint is aseptically

[1] Willard, Amer. Jour. Med. Sci., May, 1891.

[2] Le Breton, Jour. Amer. Med. Assoc., Jan. 6, 1906, 270.

[3] Bradford, Bost. Med. and Surg. Jour., 1907, clvi, 655; Tuckerman, Amer. Med., 1907, 576; Jones, British Med. Jour., March 28, 1908.

The method has many limitations, since every muscle in the paralyzed region may be involved and it is useless to transfer a weak, pale and inactive muscle having neither voluntary nor electrical contraction. A trial of at least two years should be given to electricity and massage before operating.

In planning a tenoplasty, the motions of the fingers rather than of the wrist, and of the tarsus rather than of the toes, should be considered.

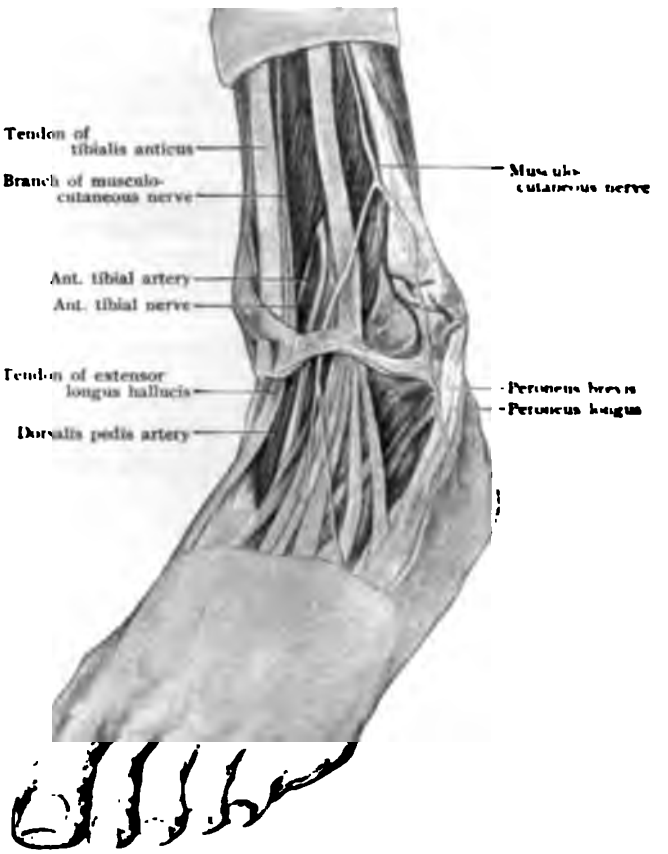

FIG. 570. Tendons and vessels in front of ankle. (Piersol's Anatomy.)

In transplantation, the tendon may be anastomosed in part or preferably in whole.[1] The muscular anatomy of the foot (Fig. 570) must be carefully studied to determine the advantage to be gained by certain transfers of power, as to flexion, adduction and abduction.[2] The ultimate benefit from tendon transplantation will usually be somewhat disappointing as the surgeon can borrow only partially useful muscles, but even

[1] Etting, Albany Med. Ann., Apr., 1902.

[2] Bradford, Amer. Jour. Orth. Surg., Nov., 1908. Goldthwait, Trans. Amer. Orth. Assoc., 1896, viii and Best. Med. and Surg. Jour., Jan. 9, 1896, Ann. Surg., xxx, 571, Silver, Penna. State Soc., June, 1906; Jopson, Penna. State Soc., June, 1907, and Univ. Med. Bull., Dec., 1907, Menciere, Cong. Français de Chir. Paris, 1907, Cong. de Reims, Aug., 1907; Vulpius, Munich. med. Woch., Apr. 25, 1899; Berlin. klin. Woch., 1898.

calcaneus and the tibials in valgus, but in cosmetic work at the wrist it will give good results. The tendon may be divided obliquely or by longitudinal mortise-like section. The required area having been removed, the ends are sutured with fine chromicized gut or celluloid thread.

In small tendons about the wrist the two ends are secured by black silk threads before section to avoid retraction and delay in operation. Compression from hemostats is harmful in a poorly nourished tendon; if an end is crushed, it is cut away before closing the wound. With thorough asepsis the wound requires no drainage and the limb is fixed with gypsum in such position as to thoroughly relax the shortened tendon. With catgut suturing of skin, the cast need not be removed for six weeks.

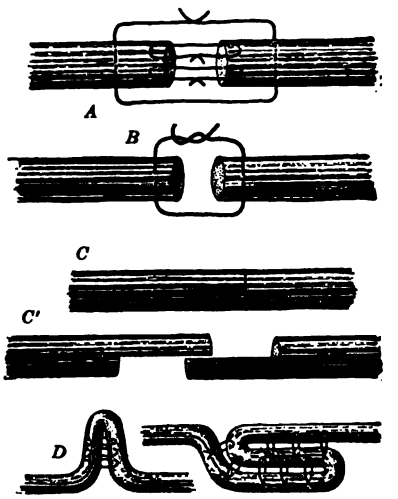

FIG. 568.—Tendon anastomosis—*A*, end-to end suture, triple and single (Monod); *B*, single end-to-end suture (Vanverts); *C* and *C'*, tendon lengthening (Anderson); *D*, tendon plication (Binnie).

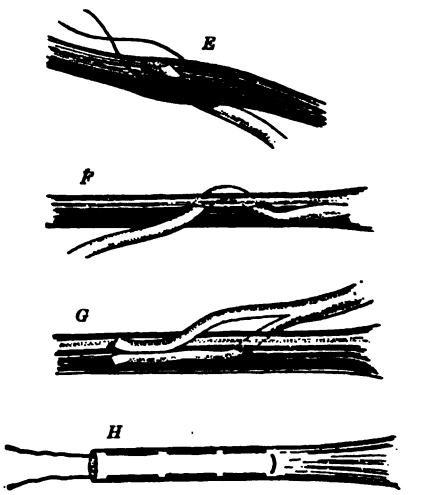

FIG. 569.—Tendon anastomosis—*E*, tendon transplantation; *F*, double insertion; *G*, split tendon insertion (Vulpius); *H*, long mattress suture.

Tendon lengthening is usually accomplished by tenotomy, but may be secured by open section. The tendon is split longitudinally and each half divided at a different level (Fig. 568), then sutured. Other methods of tendon suturing are shown in Fig. 569.

11. TENDON TRANSPLANTATION; TENOPLASTY; TENDON ANASTOMOSIS.[1] —The greatest benefit from tendon grafting will be secured by transferring a strong tendon that is increasing a deformity to the opposite side that is in need of assistance, and securing a double benefit. A flexor can thus be made to become an extensor and *vice versa*, or a pronator can be converted into a supinator. Dividing the power of a muscle by splitting and the transfer of only a portion of it requires re-education of brain and transmission power. Tendon transplantation, combined with arthrodesis (p. 628) and tendon shortening is often helpful and Vulpius has shown that even cases of progressive muscular atrophy can be benefited.

[1] See Articles by the author in Bryant and Buck's Amer. Pract. of Surg., ii, 413; also Warren-Gould's Internat. Text-Book of Surg., i, 769.

The benefit of tendon anastomosis lies in the fact, as in all cases of operation for infantile paralysis, that the bringing of one set of muscles into action is instrumental in arousing activity in other muscles that have been a long time stretched and useless.[1] A vitalized transplanted muscle under central control acquires a new function; for instance, the semitendinosus and biceps, after anastomosis into the tendo-patellæ, can be educated to become extensors instead of flexors. Preferably the muscle borrowed should be functionally related to the paralyzed one, as brain education can thereby be more readily accomplished; but extensors of the wrist can become flexors and *vice versa*. In complete paralysis or flail legs, transplantation alone cannot produce useful limbs but tenotomies and arthrodesis with subsequent mechanical support will greatly assist in locomotion (Fig. 571).

FIG. 571. — Extreme acquired paralytic valgus, scaphoid of left foot resting on the ground. Peroneals divided and outer extensors of toes transferred to the scaphoid and to the tibialis anticus. Foot dressed in varus position for thirteen weeks and good result secured.

Anastomosis should be made when the limb is in a position of overcorrection to allow for subsequent stretching of the implanted muscle. A pale red muscle is feeble; a yellow fatty one is useless.[2]

In many cases the combination of tenotomies at hip, tendon transplantation, tendon shortening, tenotomy and arthrodesis will result in an improved and strengthened walking foot. Such a result is seen in Fig. 572. Whitman[3] describes an effective operation for paralytic calcaneo-valgus, a condition which is one most crippling to the patient and perplexing to the surgeon. It consists in a combination of astragalectomy, arthrodesis, tendon transplantation and backward displacement of the calcaneum in order to bring weight-bearing further forward upon the foot and prevent relapse.

In tendon transplantation sutures should not be drawn so tightly as to strangulate the tendon and produce necrosis. Tension and compression should be avoided. Necrosis of end of tendon may be prevented by grasping with toothed forceps (Fig. 162, *M*, p. 243) or if hemostats have been used the crushed portion should be cut away after suturing. The tendons are poorly nourished with blood, the supply coming mainly from the sheath, which should be preserved. Tendons when transplanted are fed temporarily through the lymphatic stream. Fixation with gypsum is important for eight to twelve weeks, as transplanted tendon unites slowly.[4]

Jones[5] who has had large experience in transplantation insists that contracted tendons producing the deformity must be tenotomized; that

[1] Bradford, Tenoplastic Surgery, Aug., 1897.

[2] Cone, Johns Hopkins Hos. Bull., xii, Aug., 1901. Tubby and Jones, Surg. of Paralysis, p. 120, 1903. Derocque, iv., Cong. Periodique Gyn. D'Obstetrique et de Paediatrie, Gibney, Bost. Med. and Surg. Jour., May 10, 1902, 80, Whitman, Am. Jour. Orth. Surg., Aug., 1903.

[3] Amer. Jour. Med. Sci., Nov., 1901.

[4] Wilson, Amer. Med., April 8, 1905, Munch. med. Woch. Jan. 7, 1902 and Handbuch der Orth. Chir. Joachimstal, 341.

[5] Jones, Brit. Med. Jour., March 28, 1908, Jones, Trans. Congrès Français de Chirurg. Paris, 1907.

forcible straightening and other surgical pr
transplantation is attempted and the main
position continued until voluntary power is
advocates the suturing of tendon into peri
deflection of the muscle, the shortening of st
in the selection of the tendon to be transf
he adds to the temporary corrective force th
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Fig. 572.—Result of arthrodesis and tendon transplantation at right ankle for paralytic flail foot with calcaneus.

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can also be attached by silk tendon to the

Arm and Hand.—Tendon transpl
carpus to the extensors in wrist-drop is oft
cosmetic purposes.[2] The flexor tendons of
the same time, or the muscles sectioned at
If the flexors are carried around outside
wrist to reach the extensors of the fingers

[1] Soutter, Bost. Med. and Surg. Jour., June 4,
f. Chir. u. Mechan. Orth., May, 1908, 2 Heft, 255; I
567; Wharton, Ann. Surg., xlv, 635; Amer. Jour. C
[2] Hoffa, Berlin. klin. Woch., July 24, 1899.
[3] Townsend, Trans. Amer. Orth. Assoc., vol. xii

than if they are carried through the interosseous membrane. A tendon can be lengthened by splitting or by utilizing a neighboring paralyzed tendon. The pronator radii teres is transplanted by detaching its insertion, passing it through the interosseous membrane and implanting it upon the outer side of the radius, making it a supinator.[1]

The triceps may be engrafted upon the biceps or the trapezius or pectoral upon the deltoid, or the deltoid upon the triceps.

In paralysis of the serratus magnus, called winged scapula, a portion of the sternal part of the pectoralis major is separated from the humerus and transplanted into the serratus.

Transplantation of Trapezius.—For paralysis of the deltoid and upper arm, transplantation of the trapezius may be practised with advantage. A broad flap is raised from the upper arm and scapula, thoroughly exposing the trapezius which is severed from its insertion into the spine of the scapula and from the clavicle. The arm is then carried to a right angle with the body and the tense trapezius is attached to the atrophied deltoid by chromicized gut or celluloid sutures. The arm is fixed by gypsum in the abducted position for six or eight weeks. Subsequent massage, manipulation and gymnastic movements are continued for months.[2]

Transference of the rectus abdominis to the tubercle of the tibia by a long silk tendon carried down through the sheath of the rectus femoris has been done by Hunkin,[3] who has also used transplantation of the sartorius, biceps, and many other muscles. The silk is boiled six minutes in 1 : 2000 bichloride and no infection or expulsion of the silk has resulted.

After-treatment following Tenoplasty.—To remove a cast and permit a patient to use the limb without supporting the newly arranged muscles is faulty, since re-education of the brain and nerves is necessary after transplantation. Prolonged after-treatment and protection are essential, first to prevent the muscle from again being subjected to overstrain, and second to develop its contractility by long-continued massage, electricity, voluntary and involuntary muscular movements. A well-equipped orthopaedic gymnasium (p. 235) will render great assistance.

Fixation in the corrected position without operation sometimes results in a restoration of contractile power. This power may be lost if tension is again put upon such a weakened muscle. It is difficult for the surgeon to secure control of his patient long enough to be sure of success, a fact that is often observed not only in poliomyelitis but also in congenital club-foot. Constant supervision is essential until the patient by muscular action can place the sole of the foot squarely upon the floor. Overstretched muscles necessarily require a long period of massage to be able to oppose the stronger set. At the knee, the transfer of the hamstrings or sartorius to the quadriceps extensor must be followed by a long period of muscular exercise, protection and education of brain, nerve and muscle.

The surgical operations described are only intended to bring a badly deformed limb into proper position for weight-bearing previously impossible, and must not be considered as curative in themselves. They are the

[1] Tubby, Brit. Med. Jour., March 3, 1906.
[2] Bradford, Amer. Jour. Orth. Surg., 1910.
[3] Amer. Jour. Orth. Surg., Nov., 1908.

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a totally helpless pair of legs that were rer
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Fig. 573.—Legs totally paralyzed. Customary position on floor (see Fig. 576).

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[1] Willard, Experiments in Nerve Suturing, Intern
Med. News, Oct. 6, 1894, 374; Art. in Bryant and Bu
Amer. Jour. Orth. Surg., 1910.

[2] Vaughan, Amer. Jour. Med. Sci., Aug., 1908.

[3] Jour. Amer. Med. Assoc., Nov. 14, 1908, 1677.

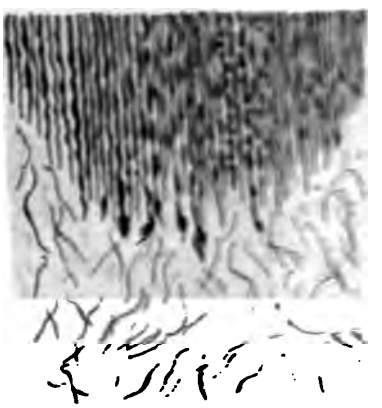

FIG. 574.—*A*, resection of half of a [illegible] nerve of [illegible]. Dog killed on forty-sixth day. From author's article [illegible]

The opposite ends of the cut portion of the nerve [illegible] united by fibrous tissue, scattered through which were [illegible] Dr. W. S. Carter.

FIG. 574.—*B*, nerve flap splicing. Resection [illegible] the nerve united end to end by catgut sutures. After [illegible] headed remains of the nerve flaps with degenerating [illegible] ment degenerated.

FIG. 574.—*C*, nerve grafting; bridge of [illegible] of ivory inserted, and stitched with catgut sutures. Wound [illegible] on thirty-second day. No signs of suppuration. Fibers [illegible] abruptly in a bulb of fibrous tissue several hundredths [illegible] and developing nerve-fibres in fibrous bridge. Remains [illegible]

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Fig. 573.—Legs totally paralyzed. Customary position on floor (see Fig. 576).

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[3] Jour. Amer. Med. Assoc., Nov. 14, 1908, 1677.

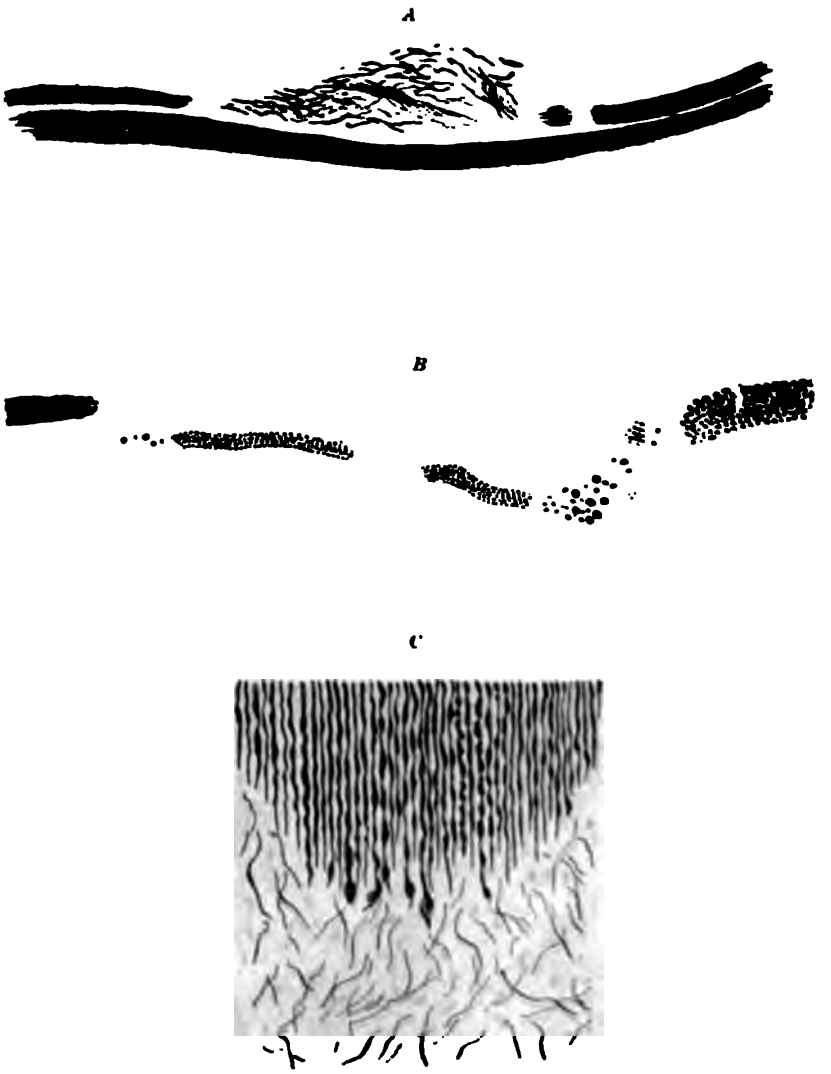
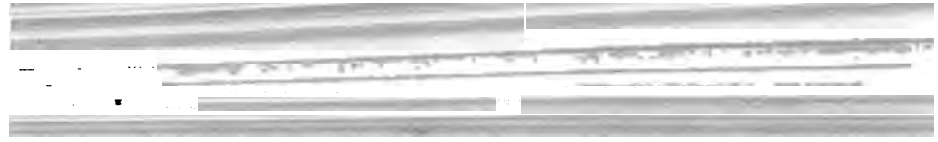


FIG. 574.—*A*, resection of half of a sciatic nerve of dog, divided ends sutured with chromicized catgut. Dog killed on forty-sixth day. From author's article in The International Medical Magazine, Apr., 1894.

The opposite ends of the cut portion of the nerve had separated to the extent of one inch and were united by fibrous tissue scattered through which were found many new nerve fibrils. Examination by Dr. W. S. Carter.

FIG. 574.—*B*, nerve flap splicing. Resection sciatic nerve, Newfoundland dog. Flaps from ends of the nerve united end to end by catgut sutures. After twenty-eight days union of nerve bridge showed healed remains of the nerve flaps with degenerating nerve tissue projecting into nerve fibrils. Lower fragment degenerated.

FIG. 574.—*C*, nerve grafting, bridge of ivory. Right sciatic nerve of dog was resected and small piece of ivory inserted, and stitched with catgut sutures. Wound united by first intention. Dog killed on thirty-second day. No signs of suppuration. Ivory encysted in the connective tissue. Nerve terminated abruptly in a bulb of fibrous tissue, several bundles being cut off obliquely. Numerous straggling regenerating and developing nerve-fibres in fibrous bridge. Reunion and transmission of nerve force perfected later. (Willard.)



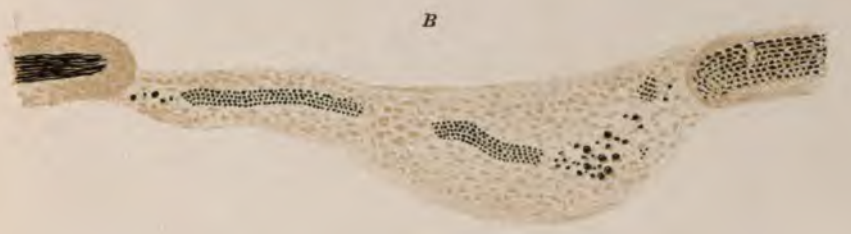


FIG. 574.—*A*, resection of half of a sciatic nerve of dog; divided ends stitched with chromicized catgut. Dog killed on forty-sixth day. (From author's article in The International Medical Magazine, April, 1894.)

The opposite ends of the cut portion of the nerve had separated to the extent of half an inch and were united by fibrous tissue, scattered through which were found many new nerve fibrils. (Examination by Dr. W. S. Carter.)

FIG. 574.—*B*, nerve flap splicing. Resection sciatic nerve Newfoundland dog. Flaps from ends of the nerve united (end to end) by catgut sutures. After twenty-eight days connective-tissue bridge showed beaded remains of the nerve flaps with degenerating myelin; no projections of nerve fibrils. Lower fragment degenerated.

FIG. 574.—*C*, nerve grafting; bridge of ivory. Right sciatic nerve of a dog was removed, small piece of ivory inserted, and stitched with catgut sutures. Wound united by ninth day. Dog killed by chloroform on thirty-second day. No signs of suppuration. Ivory encysted in the connective tissue. Nerve terminated abruptly in a bulb of fibrous tissue, several bundles being cut off obliquely. Numerous straggling, radiating and developing nerve-fibres in fibrous bridge. Reunion and transmission might have been perfected later. (Willard.)

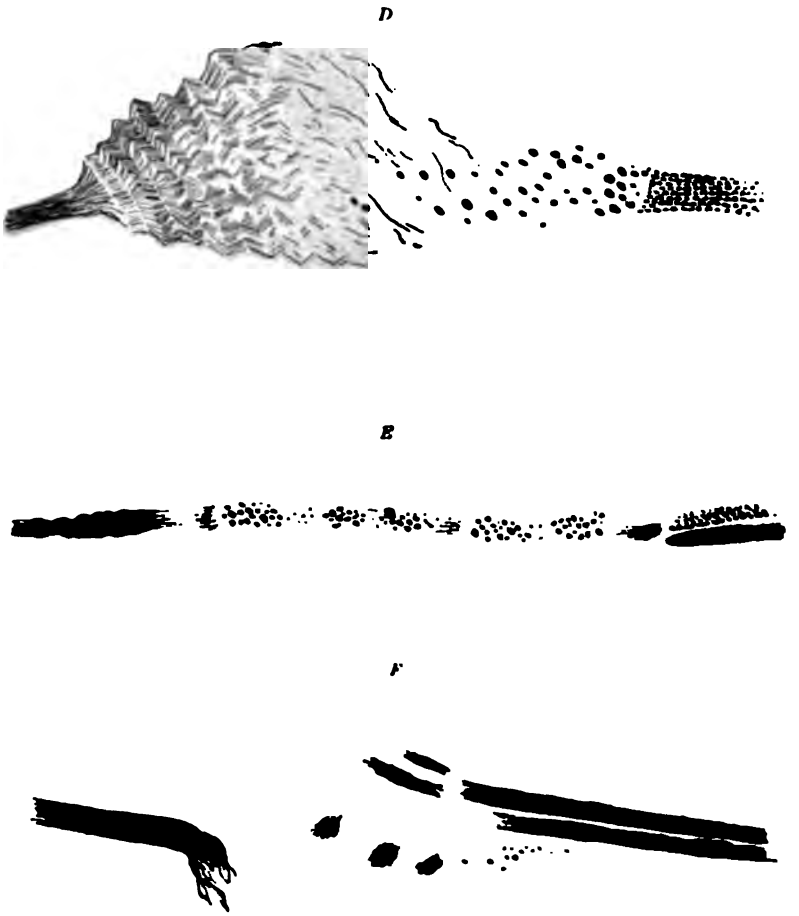
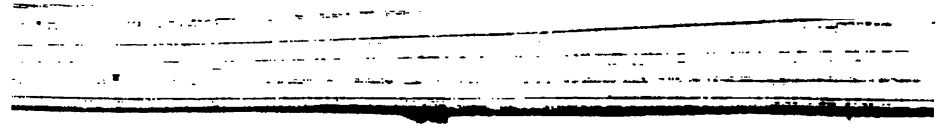


FIG. 575. *D*, resection sciatic nerve of dog; the gap bridged by a compact bundle of four strands of chromicised catgut. Specimen examined on the forty-sixth day. The proximal fragment on the left hand side terminates in a bulb of fibrous tissue containing numerous radiating nerve fibres as a fan from the termination of the nerve-fibres. Sheath continued into the fibrous tissue of the bulb. Numerous scattered nerve fibrils making their way toward the distal fragment.

FIG. 575. *E*, resection of sciatic nerve of dog; divided ends split longitudinally and the flaps turned upon their bases. Specimen examined after eleven days. In the proximal fragment and the tissue the nerve-fibres terminate abruptly in the mass of fibrous tissue without branching. In the nerves are found many patches of degenerated nerve structure. In upper end of distal fragment the fibrils are beaded and each fibre is surrounded by a sheath.

FIG. 575. *F*, retrieval of three-quarters of an inch of sciatic nerve. Long nerve ends cut to end. Specimen examined twenty-four days afterwards.

No continuity of nerve-fibres demonstrable. A few of the bundles have evidently been cut in different planes. No splitting up of fibres and no evidence of degeneration. All specimens by the author.



Since the sheath and the connective tissue between the nerve fasciculi insulate the fibrils, it follows that these fibrils should be placed end to end if possible. Such approximation consequently is better than lateral anastomosis, since a distal axone is brought into direct contact with a proximal axone favoring regeneration. The uniting material must spring from the neurilemma or neuroglia. Aseptic primary union, end to end, may give signs of sensation in two months, and of motion in three, but improvement may not be very noticeable for a year. Restoration of function is finally secured by the axis cylinders that develop in the peripheral end of the nerves,[1] these cylinders having originated in the vitalized nerve. A careful anatomical and electrical study must first be made of all the proposed operative area, supplemented by the aid of a skilled neurologist.

Fig. 576.—Following multiple tenotomies and the application of apparatus, the child was greatly startled when placed upon her feet as for twelve years her head had never been so far from the floor. Companion of Fig. 573.

Technic.—A very sharp scalpel is requisite; scissors and hemostats should never be employed, since they contuse the fibrils. The needle is of small size and round; the suture the finest twenty-day chromicized gut. The sutures are coated with sterile cosmoline and inserted longitudinally into the SHEATH ONLY, to prevent injury to nerve-fibres. They are tied snugly but not tightly. In end-to-end suture the sheath should be trimmed away to prevent it from being drawn in between the ends of nerve-fibres. Pinching and handling should be avoided. A metal electrode needle is useful for tests during operation.

Methods of Suturing.—(1) End to end; (2) lateral, (*a*) peripheral paralyzed nerve into sound nerve; (*b*) central sound nerve into paralyzed nerve; (*c*) nerve bridging, suture à distance, with inserted material.

1. In suturing END TO END the whole or a part of a sound nerve is severed. This is done when it is decided to sacrifice the innervation of a less important set of muscles for a set that is of greater consequence (Fig. 577, *C*).

Complete end-to-end anastomosis is not advisable when partial grafting of healthy fibres from some neighboring nerve is practicable. Total division of a living nerve destroys all motion in the muscle from

[1] Spiller, Frazier and Van Kaathoven, Amer. Jour. Med. Sci., March, 1906; Trans. Phila. Coll. Phys., 1905; Jour. Amer. Med. Assoc., Jan. 21, 1905; Jour. Nerv. and Mental Dis., June, 1903, June, 1905; Young, Trans. Amer. Orth. Assoc., June, 1904, and Jour. Amer. Med. Assoc., Jan., 1905; Peckham, Prov. Med. Jour., Jan., 1900-05; Orth. f. klin. Chir., 1903, 3. lxxi, 638; Amer. Jour. Orth. Surg., 1910.

which it is borrowed, while by a split section a portion of power is left (Fig. 577, *D*).

2. LATERAL IMPLANTATION.—(*a*) The implantation of a paralyzed nerve laterally into a sound nerve offers the best hope of improvement with the least injury to the sound nerve.[1] A slit is made through the sheath, the nerve-fibres exposed and separated slightly, but not divided. The naked fibres of the paralyzed nerve are then inserted against the sound fibres and the two sheaths sutured (Fig. 577, *B*).

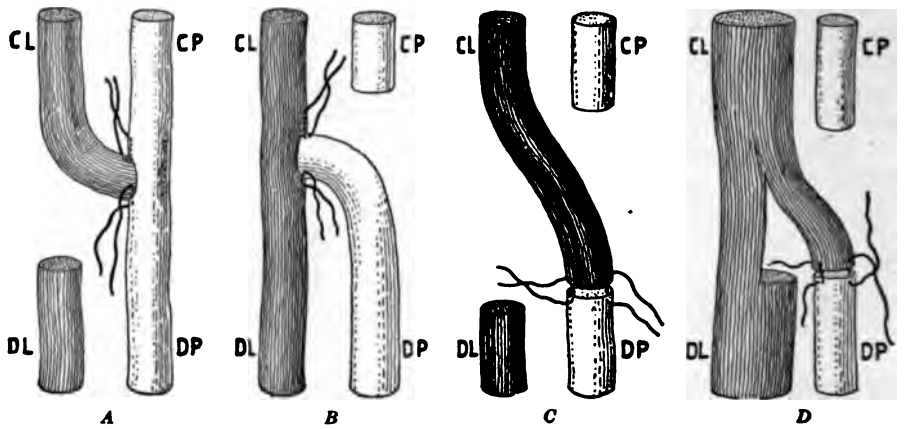


FIG. 577.—Nerve anastomosis—*CL*, central living nerve; *CP*, central paralyzed nerve; *DL*, distal living nerve; *DP* distal paralyzed nerve. *A*, lateral anastomosis of living into paralyzed nerve; *B*, lateral anastomosis of paralyzed into living nerve; *C*, end-to-end anastomosis; *D*, one-half of central living nerve transferred to distal paralyzed nerve.

(*b*) The reverse and less desirable plan is to suture the central segment of the divided sound nerve fibrils laterally within the sheath of the paralyzed one (Fig. 577, *A*).

(*c*) Nerve bridging—suture à distance. In infantile paralysis the insertion of a bridge between the ends of nerves is seldom required but in traumatic cases a portion of nerve may have been destroyed.[2] When end-to-end contact is impossible, a foreign substance, as catgut, may be employed to guide the deposit of nerve fibrils; or flaps may be cut, refolded and sutured (Fig. 578). The gap may also be filled with fresh nerve from an amputated limb or from a very young animal. The best protection from subsequent cicatricial connective-tissue encroachment is secured by enclosing the nerve in clean fascia or in animal tissue as an artery hardened in formalin,[3] or a decalcified bone, or egg-shell lining or Cargile membrane[4] (Figs. 579 and 580). Nerve bridging is not advisable

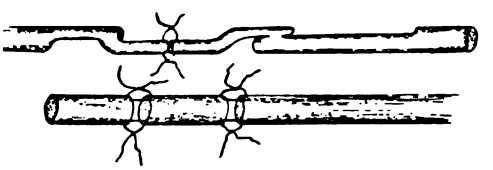


FIG. 578.—1, neurorrhaphy flaps cut from nerve refolded and sutured; 2, nerve graft.

[1] Binnie's Oper. Surg., 4th Ed., 769.
[2] Warren-Gould's International Text-Book of Surgery, 1, 868 (Willard).
[3] Murphy, Surg., Gyn. and Obstet., iv, 4, 385–500, April, 1907.
[4] Craig and Ellis, Trans. Phila. Acad. of Surg., viii, 44.

in young children nor in adolescents until all other forms of treatment have been tested.[1]

The author has tried many methods of bridging and is satisfied that flaps cut from the nerves serve as a better framework for the deposit of new fibres than any foreign insertions[2] (Microscopical Drawings, Figs. 574 and 575).

Spitzy[3] has many excellent suggestions as to technic and also records his experiments in nerve regeneration. In quadriceps paralysis he has anastomosed the long branch of the obturator nerve with the long saphenous branch of the anterior crural, the grafting being made high up below Poupart's ligament.

In Young's case[4] the tibialis anticus muscle was the principal one paralyzed. As this muscle is supplied by the musculocutaneous as well as by the anterior tibial nerve, the peroneal nerve was attached by formalized

FIG. 579.—Nerve grafting; nerve fourteen days later wrapped in Cargile membrane. (Craig and Ellis.)

gut to the musculocutaneous. The nerve was reached by incision downward from the head of the tibia and the fibres of the peroneus longus separated. The peroneal nerve was exposed and was found to divide, one fasciculus supplying the anterior tibial, another the musculocutaneous. The branches supplying the anterior tibial muscle were divided high up and inserted into the musculocutaneous and held by sutures. In another case he anastomosed the external popliteal with the internal popliteal. A

[1] Jour. Amer. Med. Assoc., March 28, 1908, 1029 and Jan. 4, 1908, 56; N. Y. Med. Record, July 11, 1908; Wien. med. Woch., Nov. 28, 1907; Ashhurst, Trans. Phila. Acad. Surg., April, 1908.

[2] Willard, Article in Bryant and Buck's Amer. Pract. Surgery, vol. ii, pp. 465–472; Nerve Suturing and Nerve Grafting; Internat. Med. Mag., April, 1894, 161; Med. News, Phila., 1894, 374.

[3] Spitzy, Amer. Jour. Orth. Surg., vol. ii, No. 1, Aug., 1904; Zeitschrift f. Orth. Chir., Bd. xiii, Heft 2.

[4] Young's Orth. Surg., 1906, 198; Jour. Amer. Med. Assoc., June 21, 1905; Trans. Amer. Orth. Assoc., 1905.

portion of the tibial may be inserted into t
unused end of a divided nerve can be prevent
inserting it into muscular tissue. The musc
of the brachial plexus may be readily transpl
median, the median into the radial[2] (Techni
can be transferred to the sixth.

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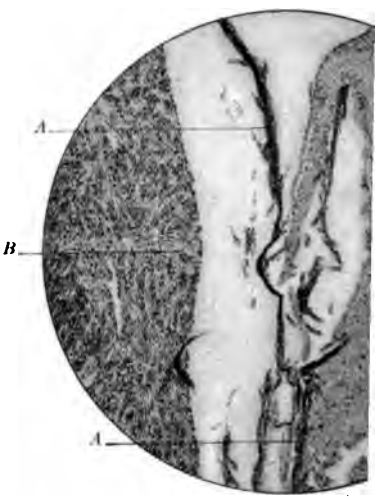

FIG. 580.—Cargile membrane. *A*, surrounding nerve

After nerve transplantation, muscle n
by voluntary and involuntary motions, mas
for a year, since regeneration may follow ev
results cannot be judged for a year or mor
case where almost complete restoration of n
after a loss of eight inches of the radial.

SUMMARY OF TREATMENT OF ANT

1. Rest during stage of tenderness.
2. Massage and electricity, continued f
3. Manipulation, stretching and frictic
4. Prevention of foot-drop while in bec
5. Apparatus to prevent deformity as

the weight of the body and develop we

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[1] Hachenbruch, Arch. f. klin. Chir., 1903, N
Gesellschaft f. Chir., June, 1903.

[2] Spiller, Frazier and Van Kaathoven, Amer. Jou
Phil. Coll. Phys., Nov., 1905; The Practitioner, 1905,
Jan., 1900, 5; Trans. 4th Cong. Italian Orth. Surg.,
Sept., 1907; Jour. Nerv. and Mental Dis., June, 190
1904, vol. ii, No. 1; Babcock, Trans. Phil. Co. Med. S

atrophy of the disease, not the brace, will result in shrinkage of the limb. Deformity is usually the result of neglect of precautionary measures.

6. In contracted and deformed joints, surgical interference to bring limbs into straight line and walking position with the body is far more speedy and humane than instrumental stretchings.

7. Multiple tenotomies, forcible correction and open incision should be practised at hip, knee and ankle; supplemented at the knee with tendon transplantation or arthrodesis and at the foot with tarsectomy, arthrodesis, tendon transplantation and nerve grafting, as needed.

8. Artificial mechanical support by braces after operation is usually required, with or without canes or crutches, with systematic gymnastic muscular development for a year or more.

9. Any form of locomotion is better than helpless dependence. No patient possessing sufficient arm power to steady himself upon crutches or wheeled crutches should be considered hopeless. Carefully planned and executed surgical, mechanical and muscular developmental methods will result in utilizing the legs and arms for some sort of locomotion, if perseveringly followed.

CEREBRAL SPASTIC PARALYSIS.

Synonyms: Cerebral paralysis of children; spastic paralysis, tetanoid pseudoparaplegia; chronic tetanus, Little's paralysis; spastic diplegia, hemiplegia and paraplegia, cerebrale Kinderlahmung

Definition.—A condition of cerebral defect varying from slight deficiency of intellect to complete idiocy, and accompanied by incoordinate, poorly controlled, irregular muscular movements, sometimes choreic or tetanoid or athetoid.

The condition is important to the orthopaedic surgeon, as these cases will be brought to him in all stages of disability, with the expectation on the part of parents that good walking powers can be secured. The defective brain control is unrecognized or unacknowledged, as adolescent and hopeless idiots will be reported as only backward and childish. In many cases the mother will insist that the child is unusually bright and the child may be proficient in music or some other accomplishment.

Etiology.—Inherited weaknesses are prime factors. The rigid spastic condition of the muscles may be noticed from birth, particularly when intelligence is low.[1] The condition in its congenital forms is found most frequently in the children of syphilities and alcoholics—drunkenness even at the time of conception favors its production. When two intensely neurotic individuals marry, it can be safely predicted that some form of spastic muscular condition will develop in their offspring. Fig. 581.

Extreme nervous shocks, lightning strokes, traumatisms, and severe illness of the mother during pregnancy may produce the condition. Deficiencies of parathyroid glands also favor tetany.

Another variety of spastic paralysis often occurs during the first five years of life from meningitis, cerebrospinal meningitis, convulsions, or intracranial hemorrhage from whooping-cough.

[1] Mills, Nervous Diseases, p. 604.

Pathology.—In congenital cases, there may be an entire absence of a portion of the brain (agenesis) with porencephalus, or an intra-uterine brain hemorrhage may have occurred with subsequent changes. Meningeal hemorrhage during birth from forceps injury is a very common cause. An obstetrician should always bear this terrible possibility in mind and use his instruments only with judgment and caution. Prolonged retention in the pelvis or compression of the placenta in protracted labor, by interfering with the proper aeration of the infant's blood, may also result in cysts or permanent deposits and pressure on the brain.

The brain of a patient with increasing epileptic convulsions and weakening mental faculties is shown in Fig. 21, p. 32. The child died from scarlet

FIG. 581.—Neglected feeble-minded paralytic who had never walked. From continued sitting on floor and bed the body had become so distorted that the left hip lay in the left axilla, the legs were crossed and twisted, and the ribs were bent at sharp angles.

fever soon after an exploratory trephining by the author for athetoid movements of right arm. The skull was asymmetrical. The sunken portion of the left hemisphere in the Rolandic area corresponded very closely with the distribution of the middle cerebral artery and may have been the result of an embolus. A large crater-like opening extended into the lateral ventricle. The large porencephalic cavity was filled with clear serum.[1]

Acquired spastic paralysis from hemorrhage, from accident, convulsions, inherited syphilis, infectious disease, whooping-cough, or the exanthemata may result in cysts, atrophy, sclerosis and softening, with descending degeneration of the lateral columns of the cord [2] or of pyramidal tracts.[3]

The paralysis may be HEMIPLEGIC, PARAPLEGIC, DIPLEGIC, or MONOPLEGIC.

[1] Willard and Lloyd, Am. Jour. Med. Sci., 1892, ciii, 381; Trans. Phila. Co. Med. Soc., 1891.
[2] Little, N. Y. Med. Rec., Nov. 30, 1907.
[3] Spiller, Phil. Med. Jour., June 21, 1902.

Symptoms.—In CONGENITAL cases the child will be tardy in sitting, walking and talking, and at five years may be advanced only to the ordinary development of two years. The muscles will be rigid or will respond feebly and uncertainly to the defective will power, at times amounting to total helplessness. The vacant facies, even in slight defectiveness, soon shows the mental condition by its distinctive expression. The eyes are set wide apart, the eyeballs are unsteady, often strabismic, saliva dribbles from the mouth and utterances are indistinct or are simply guttural sounds. Other cases show general apathy and weakness rather than paralysis. In sitting, the child relaxes the spine, producing a long kyphosis; and after tardy locomotion commences, walks upon the toes with knees and hips flexed, and with a jerky unsteady gait which mental excitement increases (Fig. 582). After standing for a few moments, the rigid muscles relax, the heels drop to the ground, but the legs are flexed, adducted and rotated, the knees knocking against each other, or the legs are crossed, scissor-legs (Fig. 583).

FIG. 582.—Cerebral spastic paralysis with unsteady gait and inverted feet.

Reflexes are increased from the beginning and the lead-pipe spastic rigidity of the leg slowly disappears upon pressure. Sensation is usually unimpaired. In congenital cases the limbs and the body develop to full size, differing markedly from the atrophic conditions of anterior poliomyelitis.

In the ACQUIRED HEMIPLEGIC form voluntary muscle power is lost on the affected side; later, reflexes are increased and the arm and leg muscles become stiff but yield slowly to pressure. Thumb, fingers, wrist and elbow are flexed. Although slight motion is retained at elbow and hand the patient is unable to grasp objects with the fingers or to feed himself. The arm is shortened and often useless. The leg is shortened, flexed at hip, knee and ankle, often with club-foot of the equinovarus variety (Fig. 582). The gait is unsteady and feeble, the leg being dragged or swung. These hemiplegic acquired paralyses should be distinctly separated from the congenital form, since up to the time of the brain hemorrhage the intelligence has been absolutely normal. Later it may be impaired by brain pressure, convulsions or epilepsy.

Diagnosis.—The symptoms of infantile spinal paralysis and of cerebral spastic paralysis are so essentially different (except in the early stages of the cases developing from acute meningeal disease) that no confusion in diagnosis should arise, if the child is examined without its clothing.

In cerebral spastic cases of congenital type, the limbs are equal and of normal size; locomotion is irregular or uncertain, the limbs rigid, reflexes exaggerated and intelligence impaired. In anterior poliomyelitis, atrophy

of certain groups of muscles is positive, locomotion is impaired or feeble, limbs are flaccid, reflexes are lost and intelligence is normal.

The enfeebled condition of tardy development in infants under two or three years of age may be also the result of rickets, or syphilis, or prolonged malnutrition, and should be closely studied while the child is naked.

Prognosis.—In congenital cases even with brain impairment, slow physical and mental improvement may be expected under proper care and training. These cases are not very resistive to the acute diseases and as a rule do not reach middle life, convulsions or epilepsy hastening the end. Hemiplegic cases from hemorrhage are very likely to develop epilepsy, and if unwisely governed and indulged, will develop violent fits of temper with dangerous tendencies.

FIG. 583.—Hips, knees and ankles flexed, legs crossed and walking impossible except with assistance.

In both congenital and acquired deformities, marked improvement will result from proper surgical measures, followed by patient muscular and mental development. It is usually unkind to disabuse the mother of her belief in the mental capacity of her child, as nothing is to be gained by such disclosure, but a guarded prognosis should be given by the surgeon as to the benefit to be expected in locomotion when operative procedures are done in imbeciles and idiots. The improvement following such operations will depend upon the amount of brain power and the persistency of subsequent muscle gymnastic training. Neurologists, concerned more in diagnosis than in treatment, may argue that operating upon a limb does not produce brain tissue, but any surgeon who has had experience knows that very hopeful mentality follows operative relief in all of this class of cases except idiots and microcephalics.[1] New powers of locomotion, contact with other fellow beings, new ideas and impressions tend constantly not only to develop muscular power but also to increase brain vigor.

Some neurologists still hold absolutely unwarranted pessimistic views, but surgeons know that many of these cases can be greatly benefited by proper attention. Skilled English surgeons like Jones,[2] Tubby and others have followed the teaching of American orthopaedic surgeons, and are endeavoring to educate their countrymen to the fact that the lengthening of a tendon lessens the undue reflex excitability of a contracted muscle by diminishing tension and restoring equilibrium. Failure will result, however, if the surgeon does not realize that this operation is but the first though

[1] Tubby and Jones, Surgery of Paralysis.
[2] Jones, Ann. of Surg., xxxvii, 1903, 415.

the most important step in securing locomotion. Patient and long-continued muscular and pedagogic training must necessarily follow up the operation.

The author for many years has insisted that these cases can be greatly improved by wisely planned surgical, mechanical and gymnastic measures and that they should not be denied these benefits.[1]

Treatment. — 1. Massage and manipulation. 2. Methodical mental training. 3. Gymnastic muscular training. 4. Mechanical support with apparatus. 5. Forcible straightening. 6. Tenotomies, subcutaneous and open. 7. Myotomies. 8. Excision of muscles and tendons and nerves. 9. Tendon and muscle transplantation. 10. Nerve anastomosis. 11. Resection of sensory roots at spine.

As soon as the lack of the muscular power is detected in the infant, systematic efforts must be made to increase the nutrition, prevent deformity and encourage walking. Massage and electricity are of use for the first, stretching and manipulation for the second.

Well-regulated, rhythmic, SYSTEMATIZED MUSCULAR EXERCISES, first passive then voluntary, must be employed as soon as the child shows sufficient strength and intelligence to practise the methods of walking with feet apart, toes everted and heels on ground. The appliances furnished in a good orthopaedic gymnasium under a competent instructor will prove of the greatest advantage (Fig. 152, p. 235).

The adductors of the thighs, hamstring and calf muscles should be prevented from contracting and the flexors of arm and hand should be stretched.

To these slowly repeated, methodical and mentally controlled muscular exercises is added patient education of the mental faculties. A skilful teacher, educated in the training of backward and feeble-minded children, will accomplish much more than a sympathetic and indulgent mother.

Apparatus is of little avail until after operation. Stretching under etherization and confinement in gypsum cast for weeks in an OVERCORRECTED position is sometimes of service. Hemiplegic cases may be assisted by braces both before and after operation.

Operative Treatment. — With heels elevated, knees flexed and thighs crossed, even a strong individual would find walking difficult or impossible; how much more so a child with brain enfeebled and muscles imperfectly innervated! Wise surgery therefore offers the surest means of benefit. The rule for operative relief should be to divide all contracted tissues.[2] At the foot the tendo-Achillis is sectioned by an OPEN oblique or mortised division, with definite lengthening and chromicized gut or silk suturing, as a SUBCUTANEOUS TENOTOMY of the tendon is liable to be followed by spastic contractions of the gastrocnemius even under a plaster cast. A

[1] Willard, article in Bryant and Buck's Amer. Practice of Surgery, ii, 519; Paralytic Cripples, Relief of so-called Hopeless Cases; Trans. Amer. Orth. Assoc., iv, 382 and vii, 326; Amer. Jour. Med. Sci., 1891, 470; Trans. Penn. State Med. Soc., xxvii, 361; Trans. Tenth Internat. Congress, Berlin, 1890, Band iii; Pediatrics, i, 193; Archives of Pediatrics, xi, 665; N. Y. State Med. Reporter, 1894, 226; Med. and Surg. Reporter, Phila., lxxv, 491; Med. News, Phila., Dec. 19, 1891, 697.

[2] Willard, Oper. Treatment, Trans. Amer. Orth. Assoc., iv, 382 and vii, 326; Trans. Penn. State Med. Soc., xxvii, 361; Trans. Tenth Internat. Congress, Berlin, 1890, iii, Section vii a.

too long tendon and a condition of calcaneus may result, especially if the flexion at the knee has not been properly corrected at the time of operation. In any case the equinus should not be overcorrected, but the ankle should be fixed for six weeks at a right angle.[1]

The ADDUCTORS of the thighs are freely divided subcutaneously at their origin from the pubes, with a strong, long-cutting-faced tenotome (Fig. 584 D and E), the puncture wound being made by drawing the skin as far as

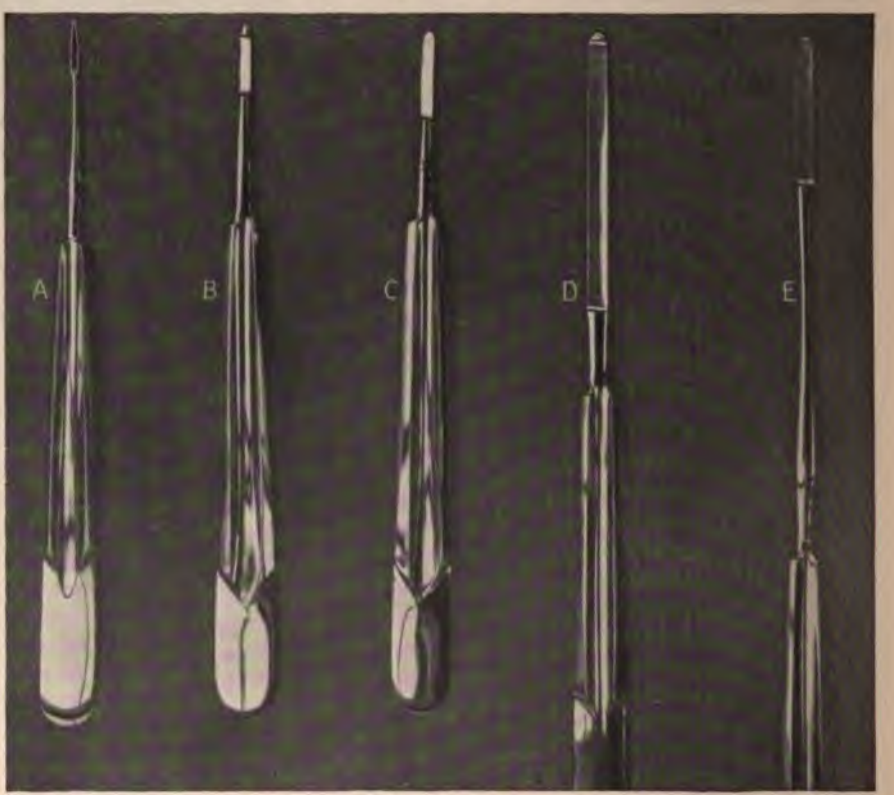

FIG. 584.—Tenotomes, notched on the back of the handles, in order that the cutting edge may be known when it is buried in the tissues. Shanks double the strength of the ones ordinarily sold in the shops. *A*, sharp pointed tenotome; *B*, probe pointed; *C*, blunt pointed; *D*, long cutting face, probe pointed; *E*, long cutting face, extra long shank for deep work at the hip.

possible toward the median line of the body in order that by its retraction, urine infection of the wound may be avoided.

The tendons of the biceps, semimembranosus and semitendinosus behind the knee are divided; the former by OPEN section to avoid the peroneal nerve (Fig. 480, p. 520). The fascia is well stretched to prevent subsequent pain.

The adductor wounds are then dressed with aseptic gauze and collodion and the other incised wounds closed with catgut so that the bulky aseptic dressings need not be disturbed for weeks. To secure a long splice in the

[1] Townsend, Trans. Amer. Orth. Assoc., 1900, xiii, 193.

adductor muscles the weight of the heavy plaster casts from perineum to toes is sufficient to maintain an abducted position. If the feet are fastened to the side bed-rails this dressing is more comfortable than a stiff body cast.

EXCISION of a portion of the adductors or NEURECTOMY of the obturator nerve will prove of benefit in relapsing cases of adduction.

Tendon Transplantation.- Transplantation offers the double advantage of lessening the deforming undue action of a muscle by transferring its influence to the opposite side, thereby aiding in balance of power.

If the tenotomy of the hamstring muscles at the knee fails to relieve the permanent flexion, the tendons may be transferred to the quadriceps (p. 634). Tendon transplantation is of less service in spastic cases than in the deformities of infantile spinal paralysis, but may occasionally prove of advantage, especially in the arm and for *cosmetic* purposes. In hemiplegic flexions the flexor carpi radialis and ulnaris may be detached from their insertions, carried around the bones or through the interosseous space, and sutured to the sectioned and shortened extensors of the fingers, or into the fascia or periosteum on the dorsum of the carpus.[1] Chromicized gut or celluloid thread is used, or silk boiled in sublimate solution 1:1000, then in paraffine (p. 632) if lengthening of tendon is necessary. (For technic, see p. 631.) A wrist ankylosed by ARTHRODESIS is less disfiguring than a flexed hand.

Transplantation can be combined not only with shortening of the extensors but with tenotomy of the flexors at the wrist, or with open section or myotomy of the flexors and pronators at their origins in the upper forearm, or with the anastomosis of a pronator into a supinator. The author has found this supplementary cosmetic operation a decided improvement, as in the majority of cases the arm is already useless. The hand is for eight weeks fixed with gypsum in an overcorrected position.

Three months after transplantations in the lower limbs, locomotion should be encouraged by suspending the patient in a leather jacket from an overhead trolley support (Fig. 152, p. 235) and by the application of suitably planned braces and apparatus, with crutches or wheeled crutches or canes.

Massage, manipulation, and systematically regulated gymnastic exercises are maintained for a year or more, until the individual can walk with precision.

Neuroplasty or Nerve Anastomosis. Nerve transplantation offers a little hope of relief when the nerve that supplies a group of spasmodically contracted or athetoid muscles can be reached, the object being to so equalize muscular power that purposeful movements can be made.

A careful study of the innervation of the parts is necessary, with the assistance of a skilled neurologist. A vitalized nerve may be transferred in its entirety or a portion split off and anastomosed to the paralyzed one, loop stitches being placed in the sheath to prevent its escape. A sterile me-

[1] Willard, Bryant and Buck's Amer. Practice of Surgery, vol. II, 493; Jopson, Univ. of Penna. Med. Bull., Dec., 1907; Trans. Med. Soc. Pa., 1907. Vulpius, Berlin. klin. Woch., Ixii, 1906; Tubby and Jones, Brit. Med. Jour., March 3, 1906. Ashhurst, Amer. Jour. Med. Sci., 1907; Amer. Jour. Orth. Surg., 1910.

tallic electrode is useful during operation.[1] End-to-end, lateral, complete and partial anastomoses are shown in Fig. 577, p. 638.

A small round sewing needle and fine well oiled chromicized gut or celluloid or silk thread are used and the loop ligatures made to include the sheath with as little injury as possible to the nerve-fibres. In lateral anastomosis the insertion is made by slitting the sheath and placing the fresh borrowed nerve close against the nerve-fibrils (technic, p. 638).

As primary union is vital, absolute asepsis is essential.

In a case of violent athetosis of the arm the nerves were exposed in the upper portion and the ulnar, median and musculospiral carefully isolated. After the insertion of holding loop stitches, the ulnar was divided and both proximal and distal ends implanted into the musculospiral.[2] The median was divided and the central end enveloped in Cargile membrane was implanted into the musculospiral, and the distal end into the distal segment of the ulnar. As the biceps still continued to act spasmodically in spite of the rigid fastening of the arm to the body by gypsum bandage, the circumflex and musculocutaneous were subsequently exposed, the central end of the musculocutaneous being sutured to the peripheral end of the circumflex and the central end of the latter sutured to the peripheral end of the former.

In the other arm, the proximal portion of the circumflex was inserted into the distal portion of the musculocutaneous and the distal portion of the former into the proximal portion of the latter. The proximal ends of median and ulnar were united by lateral anastomosis with the distal end of the musculospiral. The result of the operation was of decided relief in the athetoid movements and marked improvement in control of voluntary flexion and extension of hand and fingers.

The division of a nerve within its sheath is sometimes helpful.[3]

Division of the Sensory Roots.—The relief of this spastic action of muscles is a difficult problem. Resection of the sensory spinal roots of nerves seems to offer hope of success. The restoration of balance by adding a sensory disturbance to the existing motor disease has been accomplished by Foerster,[4] Gottstein,[5] Spiller and Frazier,[6] Clark and Taylor[7] and others. The alternate sensory roots in the lumbar enlargement have been removed with benefit. In other cases, unilateral laminectomy has been performed with section of these sensory roots from the twelfth dorsal to the fifth lumbar. The relief from spasticity permits regulated movements if subsequent muscular training is employed. As the origin of the roots of the spinal nerves does not correspond with the point of emergence from the vertebræ, a careful study of the anatomy is essential (Fig. 585).

When the athetoid movements in an arm are constant and disabling, an AMPUTATION at the SHOULDER-JOINT is permissible.

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[1] Surg., Gynec., and Obst., April, 1907. Powers, Trans. Amer. Surg. Assoc., xxii.

[2] Jour. Nerv. and Mental Dis., May, 1905; Trans. Phil. Coll. of Phys., 1905, xxvii; Spiller, Frazier and Van Kaathhoven, Amer. Jour. of Med. Sci., April, 1906, cxxxii, 430.

[3] Nutt, Amer. Jour. Orth. Surg., Nov., 1909, 151.

[4] Foerster and Tietze, Zeitsch. f. Orth. Surg., Oct. 22, 1908, xxii.

[5] Amer. Jour. Orth. Surg., Aug., 1908, 140, and May, 1909, 758, Nov., 1909, 262.

[6] Univ. Penna. Med. Bull., xxii, 314. Amer. Jour. Med. Sci., April, 1910.

[7] N. Y. Med. Journ., 1910, xci, 215.

TREPHINING of the skull in hemiplegic cases, unless performed immediately after a hemorrhage, has not proven of much benefit even for epilepsy.

Craniectomy. — The excision of a furrow in the skull by gnawing bone forceps, to permit expansion of the cranium in microcephalus, has failed from the fact that the skull is small because the brain is small, not *vice versa* (p. 30).

The removal of adenoids[1] is sometimes of service.

Circumcision. — Hundreds of cerebral spastic cases have been circumcised under the false diagnosis that the incoördinate muscular movements were due to reflex paralysis from balanitic irritation or retained smegma. Preputial adhesion is practically a normal condition at birth and is readily separated by the fingers during the first month of life. If the prepuce is early made movable over the glans, cleanliness is easily secured and the sensitive head of the organ permitted to receive the protection to which it is entitled during the early years of life. An adherent prepuce is but APPARENTLY a contracted prepuce in a large majority of cases. Only a true contracted and phimosed prepuce requires circumcision in a normal child, but as many of these cases are idiotic and liable to be uncleanly and to become masturbators, there is no objection to the removing of every possible source of sexual excitation (Phimosis and Circumcision, p. 201).

FIG. 265. Relations of the spinal nerves to bodies and spinous processes of the vertebræ. The positions of the letters and numbers clearly indicate the parts. (Mills, Gowers.)

SUMMARY OF TREATMENT.

1. Manipulation begun in infancy, continued until the child walks; then methodical education of muscles in an orthopaedic gymnasium under a trained instructor, with stretching, and massage.

2. Pedagogic and disciplinary education of brain by a teacher experienced in the skillful training of backward and defective children.

3. Tenotomies and myotomies to restore the equilibrium of power, enable the child to walk, and to mingle with his fellows and acquire an education.

4. Tendon and nerve transplantations and division of sensory roots within the spinal canal.

5. Mechanical support.

6. Continuance of muscular and educational training through life.

Spinal Spastic Paralysis. — A few cases of spastic paralysis will be noted that are apparently spinal, not cerebral.

[1] Cornell, Backward Children, p. 46.

ISCHEMIC PARALYSIS.

Synonyms: Volkmann-Leser contracture of hand and fingers; contraction myositis.

The inclusion of a nerve in the callus of a fracture, or the direct crushing of a nerve at the time of accident, or the subsequent too tight application of a bandage upon a wooden or metal splint, may result in devitalization of the skin, muscles and nerves to such extent that subsequent sloughing, cicatrization and condensation will result in paralysis and contracture.[1]

Swelling after fracture or traumatism is so common that no splint should be neglected or allowed to remain that is giving pain, whether it be wooden, metal or gypsum. A gypsum splint should always be split up before it is thoroughly hardened, to allow it to be spread open to accommodate the swelling (p. 244). Muslin bandages should be cut and loosened if either pain or interference with circulation appears. Compression between two wooden splints is especially dangerous.

FIG. 586.—Contraction at wrist from pressure paralysis. Fingers flexed if wrist is extended.

In the usual deformity, the fingers and hand are permanently flexed and often useless both from the contraction and the stretching and loss of power in the extensors. The muscles are atrophied and bound firmly together, the muscle-fibres being replaced by connective scar tissue.[2] When forcibly straightened, the fingers spring back into their deformed position, but if the wrist is flexed the fingers can be extended. Electrical irritability of the muscles is diminished. Eighty per cent. of the cases occur in children. The forearm is the ordinary site[3] but other regions of the body may be similarly affected. The author in consultation saw the results of an osteotomy of the leg where serious infection had evidently occurred and in which sloughing and contraction had so interfered with vitality as to produce a useless foot, and amputation finally became necessary.

Treatment.—An X-ray skiagram will often reveal the position of pressure. Jones[4] advises manipulation rather than operation. Five independent padded sheet-iron splints are applied to the five fingers in an extended position during strong flexion of the wrist. The palm and wrist

[1] Powers, Jour. Amer. Med. Assoc., 1907, 759; Sayre, Amer. Jour. Orth. Surg., Nov., 1908, 221.

[2] Huntington, Cal. State Jour. Med., July, 1907; Powers, Jour. Amer. Med. Assoc., March 2, 1907, and xlviii, 759.

[3] For collection of 107 cases and Bibliography, see Ann. Surg., March, 1909.

[4] Jones, Amer. Jour. Orth. Surg., April, 1908, 371; Liverpool Med. Chir. Jour., Jan., 1909; Practical Med. Series, 1909, vii, 217.

are left free and the patient directed to systematically extend the metacarpophalangeal joints, both voluntarily and involuntarily. In a few days these splints can be extended along the palmar surface as far as the wrist, and movements continued. After another week the splint can be lengthened from finger-tips to elbow, and gradual dorsiflexion increased for weeks until palmar contractility is lost. The splints are then removed, massage and electricity applied and hand and wrist movements encouraged.

If improvement does not follow the above methods of treatment, the nerve should be exposed first above, then below the cicatrix, and the nerve carefully dissected from its compressing fibrous environment. The mass of cicatricial tissues can sometimes be extirpated. Injured tendons are united with chromicized gut or kangaroo strands. Nerves are spliced and sutured[1] or bridged by the nerves of puppies or other young animals, which nerves are transplanted and protected by tunnels of hardened dog arteries or decalcified bones. (For technic, see p. 637.)

In order to prevent recontraction, a covering roof or bridge is thrown across the nerve by Cargile membrane or by a flap from any neighboring fascia. In cicatrices from deep burns the nerve is often destroyed. Redundant callus and exostoses, as revealed by palpation and the X-ray, should be chiselled away. Pressure from the dislocated head of a bone can be relieved by reduction, or, when necessary, by excision of the head as discussed under Unreduced Dislocations (p. 555). Massage and electricity both before and after operation are important, with protracted voluntary and involuntary muscular exercises.

SHORTENING OF THE BONES OR LENGTHENING OF THE FLEXOR TENDONS is of cosmetic service.

NEUROLYSIS, or nerve-fibre separation is sometimes of benefit.

Paralysis of Lower Arm, Traumatic. In certain cases of fracture at the elbow, paralysis results from the original injury, or from wounds.[2] The musculospiral, ulnar or radial may be involved. The paralysis may be temporary or persistent. In a recent case observed by the author, the musculospiral was injured by the sharp protruding fragment in a compound fracture of the humerus. Paralysis of the hand extensors followed with wrist-drop. The nerve was exposed, cleared from bone callus and cicatricial tissue, and a flap of fascia placed beneath it. Paralysis of the ulnar nerve with loss of motion and sensation in the little and ring fingers may occur when the elbows lie for months upon a mattress during a long, exhaustive disease.

BIRTH PALSY: OBSTETRICAL PARALYSIS OF THE ARM.

Violent traction and twisting of the head and neck or traction by a hook in the axilla in the extraction of a head or breech presentation, may result in the child's being born with an arm totally helpless. The paralysis is caused by a stretching or rupture or contusion of the brachial plexus branches derived from the fifth and sixth cervical

[1] Willard. Nerve Transplantation. Bryant and Buck's Amer. Practice of Surgery, ii, 472. Inter. Med. Mag., April, 1894. Med. News, Oct. 6, 1894.

[2] For "Wounds of Various Nerves" see article by author in Bryant and Buck's Amer. Practice of Surgery, ii, 463-483.

The nerves exhibiting the greatest loss of power will be the circumflex, the suprascapular, musculocutaneous and musculospiral; the deltoid muscle and the supinators and external rotators may be partially or totally involved. The arm hangs by the side, slightly abducted, the humerus and forearm strongly pronated and fingers flexed over a rigid thumb. Fracture or dislocation may coexist. If unrelieved, the member becomes permanently fixed in this position, the shoulder capsule shortened and the internal rotators of the humerus and pronators of the forearm contracted (Erb's type). Growth does not take place, the arm and hand being stunted and the member useless (Fig. 587).

Prognosis.—Unless improvement takes place speedily after the subsidence of inflammation, the prognosis is very unfavorable. Radical measures should be early adopted.

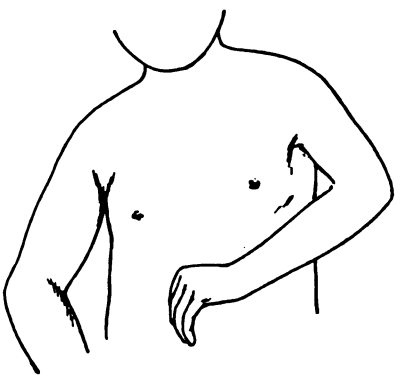

FIG. 587.—Birth palsy from injury of brachial plexus. Arm shortened, atrophied, and forearm permanently pronated.

Treatment.—The infant presenting such a helpless arm should be at once carefully examined to detect the presence of a shoulder dislocation or fracture or separation of the epiphysis. A direct injury should be suspected when traction has been made in the axilla and immediate reduction should follow. If uncertain, an X-ray may give an indistinct shadow. If the head of the humerus is in position, two months of perfect rest of the arm flexed across the breast and secured by a bandage will suffice to reduce inflammatory symptoms and permit possible union of nerves. After this time, gentle massage, correction of malposition of arm and hand, hot air, and electricity, either faradism or galvanism, should be used. If there is no improvement in six months, the prognosis is so unfavorable that operative interference is advisable.

Operations.—1. Stretching of the pectorals and invertors and pronators under ether, followed by forcible external rotations and gymnastics of supinators has proven of service.

2. Exposure of brachial plexus,[1] removal of scar compression tissue, suturing of the torn nerves by bridging or by nerve flap or by catgut. The incision [2] is made along the posterior border of the sternomastoid to the junction of the middle and outer third of the clavicle; the omohyoid and the vessels are retracted and the upper cords of the brachial plexus (Fig. 54, p. 73) beneath the deep fascia exposed between the anterior and middle scalene muscles. Scar tissue should be dissected out. The torn nerve cords are freed, freshened and united with fine sutures [3] of chromicized gut and a covering of fascia or of Cargile membrane applied (p. 639). If densely cicatrized, resection of a portion of the trunks and the transplanting of the

[1] Keen's Surgery, ii, 737.
[2] Brit. Med. Jour., 1903, 298.
[3] Willard, Nerve Suture, Bryant and Buck's Amer. Practice of Surgery, ii, 470.

two cords into the three peripheral branches are serviceable. The wound is aseptically closed without drainage and a plaster cast applied for five weeks to hold the head in a position to relax the muscles and nerves, after which time a sling should be worn for two more weeks.

Either with or without operation, these cases require long and patient efforts to prevent the permanent deformities. The internal rotators of the humerus, the pectorals and the teres, must be persistently stretched.

3. Neurolysis or disassociation of brachial nerve-fibrils has been performed for birth palsy,[1] for cicatricial contraction of nerve, for painful neuritis and for neuralgia.

An incision is made into the nerve sheath, relieving pressure, and the nerve-fibres carefully separated longitudinally with a sharp tenotome in order to interfere as little as possible with axis cylinders. In cicatricial regions the fibres after separation are protected from future contractile pressure by inserting beneath and between them fatty or fascial strips from the neighboring areas.

4. Open myotomy of the insertions of the pectoralis major and inverting muscles of the humerus and open section of the pronator radii teres, or transplantation of the pronator to the supinator with tenotomies of the flexor tendons of the fingers, will at least improve the appearance of the arm.[2] If the deltoid is permanently paralyzed and other muscles retain even a moderate amount of vigor, increased arm movement may be secured by transplanting the trapezius to the deltoid (p. 635).

5. Arthrodesis of the shoulder-joint is sometimes advisable to secure the use of the trapezius and serrate muscles. The capsule is opened by separating the deltoid fibres, the bone turned out and the cartilage removed from head, acromion, glenoid and coracoid. The bone is then wired to the acromion and glenoid and fixed in abduction for three months or more.

Parturition Paralysis. Pressure of a large child's head upon the pelvic nerves or the pressure of forceps may produce a temporary and sometimes persistent paralysis of a certain group of muscles, most frequently the PERONEALS, with the deformity of FOOT-DROP. This paralysis may take place in young adolescents as occurred in a patient of the author, who became a mother before she was twelve years old. The loss of power will be noticed at once, or as soon as the patient attempts to walk. The pain may be dull and aching, or tingling, according to the degree of neuritis. The sciatic, gluteal, crural or leg regions may be involved. In cases of multiple and persistent neuritis, the cause is usually toxic from septic puerperal autoinfection.

Slight cases recover speedily, but those of severer type require persistent electricity and muscle development. Nutrition should be stimulated by mild massage as long as the muscles do not show the reaction of degeneration (p. 616). Apparatus to prevent muscle stretching and toe-drop should be at once applied.

[1] Babcock, Ann. Surg., Nov., 1907, xlvi., 686.
[2] Binnie's Oper. Surg., 4th Ed., 777.

OCCUPATION PALSIES.

Synonyms: Writer's cramp; scrivener's palsy.

Artisans, stenographers, typewriters, watch makers, musicians, in fact any individuals compelled to execute repeated definite muscular movements, are liable to so tire and exhaust local muscular and nerve power that a form of paralysis or neuritic cramp ensues.

This disability may be TREMULOUS, SPASTIC, or PARALYTIC. In many cases it is simply an expression of muscle fatigue; in the more serious forms it is a reflex neurosis, the incoördinate movements ending in paralysis. In the tremulous cases, irregular muscle action is easily excited by the usual avocation. In the spastic type, the contraction may be clonic or tonic.

The first symptom is weakness, followed by cramping pain occasioned by holding the pen or other tool, followed by tremulousness or paralysis.

Prognosis.—Unfavorable, unless the patient can change occupation, or give the muscles a long rest.

Treatment.—Rest for the tired muscles and restoration of general health are of absolute importance. Unfortunately, these patients are usually of the class that cannot afford the advantages of change of air and scene. A change of occupation is often the only hope of cure in severe cases, and as the left hand can be educated to do the work of the right, as is plainly seen in patients who have lost the right arm, it only requires patience and perseverance to educate the other hand. When the patient is unable to change occupation, various mechanical devices for transferring the daily work to other muscles are used. For writers, a socket for the pen can be attached to the thumb and fingers so that no grasping muscle power need be exerted and the larger muscles of the forearm, instead of the weaker hand muscles, are used. Neither nerve stretching nor tenotomies have proved of any service.

Rest must first be secured upon a splint, confining fingers, thumb and forearm. Not until pain and cramp have disappeared can benefit be expected from massage. In the paralytic type both massage and electricity are helpful, but only to increase nutrition; in the spastic type, rest and slow regulated movements of the hand and fingers are needed, followed by other measures such as electricity, electric light, radiant heat, cabinet bath, and high-frequency current.[1]

PARALYSES FROM PRESSURE.

Crutch Paralysis.—Numbness, tingling and paralysis may follow the use of crutches when the patient has not been properly instructed by the surgeon to place the weight of the body upon the hands on the cross-bar of the crutch, not on the tissues in the axilla.

The prognosis is good, if the earliest symptoms are recognized and the proper precautions taken to avoid pressure. In young children, a perineal and ischiatic crutch like a Thomas knee splint (p. 513) or a Taylor hip brace (p. 478) may be substituted for hand crutches.

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[1] Willard, Article in Bryant and Buck's Amer. Prac. of Surg., ii, 510.

Paralysis from Esmarch Bandage.—The application of a rubber bandage or tourniquet is sometimes followed by a paralysis that is distressing to both patient and surgeon. It is advisable therefore to avoid this form of hemostasis when possible, except in the more delicate operations when a view of tissues free from blood is necessary. The few moments thus saved during the immediate operation are often lost in arresting hemorrhage after the bandage has been removed. The loss of nerve and muscle power sometimes lasts for months even after slight operations, but will yield in time to the ordinary relief measures, as the cause is temporary.

Anesthesia Paralysis.—Akin to the paralysis of the Esmarch bandage is the still more discreditable one that occurs from pressure on the musculospiral, ulnar or median nerves when, during anesthesia, the arm is allowed to lie over the edge of the operating table. While the toxic effect of the anesthetic may be a partial factor in this loss of power, yet it is the duty of the anesthetist to completely guard the position of the arms. Pressure on the shoulders in the Trendelenburg position may also cause paralysis of the circumflex.

Paralysis from Ligation of a Nerve. The accidental inclusion of a nerve within a ligature during an operation may result in tetanus or in paralysis. The thorough freeing of each vessel from its surrounding tissues and the use of absorbable ligature will avoid such a result.

Paralysis from Loss of Nerve.—A nerve may be accidentally or purposely divided or removed during the course of an operation or the section may be the result of an accident.

Immediate suturing should be the rule.[1] When discovered late, secondary suture or nerve anastomosis will often give excellent results. Splicing by transfer of sections of a nerve (Fig. 577, p. 638) will give increased length.

The author has recorded a case where almost complete restoration of motion and sensation took place in ten years after the loss of eight inches of the radial.

TREATMENT.—During the sensitive stage of neuritis, rest should be the rule; afterwards gentle massage, galvanic or faradic electricity followed by involuntary and voluntary gymnastic muscular movements are helpful for all of the foregoing varieties of nerve-pressure paralysis.

Deltoid Paralysis. Paralysis of the deltoid not infrequently follows a blow upon the circumflex nerve on the outer surface of the shoulder and arm. This muscle is also frequently paralyzed in infantile spinal paralysis (p. 611) or from injury of the nerves in the axilla, or from a myositis, or from laceration, or from neuritis secondary to traumatism. Injury of the nerve may also take place from luxation of the head of the humerus. In many cases contusion also plays its part. Cicatricial contracture after ulcerated wounds will also interfere seriously with deltoid action. Diagnosis is not often difficult, as there is loss of power and atrophy in the deltoid, and a flattening of the muscle with prominence of the acromion. The chief error in diagnosis will be when a shoulder arthritis has been developed with subsequent atrophy.

[1] Willard, Bryant and Buck's Amer. Practice of Surgery, vol. ii, 496, Nerve Suturing. International Med. Mag., April, 1894; Nerve Grafting, Medical News, Oct. 6, 1894.

PROGNOSIS should be guarded, but compensatory development of other muscles will in time improve the movements of the arm. If there is complete loss of reaction of nerve and muscle to electrical currents, the chances of recovery are small, but when reaction is present, improvement is to be expected.

TREATMENT.—Rest will be essential during the acute painful stage. Dry or moist heat and later, gentle massage, electricity and voluntary and involuntary movements are of use. The high-frequency current gives relief in pain. Acetanilid and codeia are helpful, as are also injections of chloroform. Tendon transference of pectoralis or trapezius is helpful.[1]

Paralysis of Serratus Magnus.—A weakened serratus magnus is frequently found in lax and indolent patients, allowing the inferior angle of the scapula to protrude and form the prominent "wings." In many cases, this scapular tilting is due to rotary lateral curvature of the spine elevating the ribs beneath; in other cases the outward tilting is due to the latissimus dorsi having been torn from its attachments as it crosses the tip of the scapular angle. Scoliosis may or may not be present. Sayre contended that the principal agent in correcting rotation in lateral curvature depended on development of the serratus and through its action influencing the ribs and vertebræ.

SYMPTOMS.—While the position of the scapula is the most prominent symptom, the inability to lift the arm beyond the right angle is also to be observed. The trapezius may share in the paralysis if there has been an injury sufficient to cause interference with the nutrition of both muscles, which are supplied by the long thoracic nerve.

The condition may result from carrying heavy weights on the shoulder, or by direct traumatism, or by violent muscular exertion. In a few cases of birth palsy, the serratus, as well as arm muscles, will be involved. The pectoralis minor, if active, also tends to tilt out the inferior scapular angle.[2]

TREATMENT.—Massage, electricity, and gymnastic muscular development are indicated. The scapular muscles are best exercised by holding shoulder and elbow stiff, while the shoulder-blade is moved in various directions in connection with chest weight or Whitely exerciser (Fig. 200, p. 271).

Paralysis of Supra- and Infra-scapular Nerves.—Contusion, neuritis or muscular strain in gymnasium or in work may cause loss of power in these nerves and they become weak and painful. The muscles atrophy and the fossæ flatten. Loss of power in the levator anguli scapulæ may exist and electrical reactions are lost; external rotation of arm, elevation and abduction of the arm are impaired.

The accessory and vicarious muscles as well as the ones involved must be developed by electricity, massage and gymnastic movements.

Paralysis, Facial.—Unilateral facial paralysis (Bell's palsy) in infants is usually the result of forceps pressure, or from bony pressure while passing through the pelvis. Later, traumatism or surgical operations for adenitis and tumors or mastoid disease will act as causes.

The prognosis is usually favorable if mild electricity and gentle massage are employed.

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[1] Amer. Jour. Orth. Surg., 1910.

[2] Bunts, Trans. Amer. Surg. Asso.

TRAUMATIC NEUROSES.

Synonyms: Neuromimesis; hysterical, neurotic, sensitive or functional joint; railway spine; traumatic spine; hysterical paralysis

To denominate traumatic neuroses as hysteria is misleading, since the term as usually applied indicates a certain amount of simulative deception or exaggeration.[1] Exaggeration is an undoubted element but this may be without any intention to deceive. These cases are often called neurotic because diagnosis has not been properly sought. Any individual who has been injured and has lain months in bed will undoubtedly have sensitive and painful joints on attempting locomotion. This will be as frequent a symptom in patients who are not seeking redress for their injuries as in those who contemplate legal procedures, but the disability will not be as long continued in the former as in the latter class. The craving for sympathy in every individual, and especially in a neurotic female without special cause to arouse ambition, will often indefinitely prolong the period of sensitiveness and pain. It requires a greater amount of fortitude and endurance than is possessed by the ordinary individual who for months has been carefully nursed and guarded, to rise and submit to movements which will undoubtedly awaken severe pain. These pains, however, are inseparable from a resumption of motion. The exaggerator and the malingerer will of course always exist and it will require the closest and wisest scrutiny of the surgeon to separate the real from the unreal.

Examination.—For examination the patient should be nude, especially if the spine is implicated. In injuries of the lower limbs an inspection of the whole body and the method of locomotion is essential. The patient should be examined lying, sitting, standing and walking. The dynamometer, esthesiometer and electricity may all assist in diagnosis.

SENSITIVE KNEE is discussed on page 537. SENSITIVE HIPS are most common in girls about puberty, especially in those desiring to avoid work. A careful study of the presented symptoms of limp, pain, flexion, rigidity, and thickening must be compared with those of real disease, since all of these may be simulated or exaggerated.

Thorough anesthetization is very important, but violence must not be used if any suspicion of tuberculosis exists. The X-ray will show the absence of bone destruction.

If rest has been enforced too long after a sprained ankle, sensitiveness and pain will be certain. Foot-drop is not uncommon after injuries at the ankle.

The author recalls a child who had been run over by the carriage of a physician. The mother threatened to bring suit and exhibited as evidence the helpless limb of a girl that would have excited great sympathy with a jury. An examination three days after the accident, however, showed no injuries but a leg atrophied from anterior poliomyelitis with paralyzed muscles and foot-drop. Inquiry among neighbors speedily confirmed the diagnosis that this condition had existed for years.

SPINE. Any patient after long confinement in bed from injury in the back will undoubtedly continue to suffer pain upon rising, even when no

[1] Willard, Article, Traumatic Neuroses, Bryant and Buck's Amer. Practice of Surg., ii, 509-516. Neuromimesis, Internat. Text-Book Surg., Warren-Gould, i, 721.

medicolegal question is involved. A concu
the accident, contusion of the muscles an
ing of spinal ligaments or pulling up of p
tion or fracture, all combine to give pain
from physician or friends will convert mar
chondriac, and when a damage suit is in
be much in evidence. The unwise state
case is hopeless have done much to prod
not mean that the patients are necessari
individual is more or less mentally influen

FIG. 588.—Traumatic neurosis with contractions.

may require operative measures (Fig. 588)
be assisted by a study of the ocular conditi
side, paresis of accommodation, and cont
pupils are sometimes to be found. In h
muscular atrophy and electrical reaction
of tuberculosis or of gouty neuritis or rhe
are found, change of scene and an occupa
introspection will be of great service.

Treatment.—Before commencing ac
be certain that there is no actual disease
lest permanent injury be inflicted (Treat
500). After an anesthetic and gentle m
must be encouraged to use voluntary
painful. Daily massage and muscular
will accomplish wonders. The author re
on crutches for years, but have regaine
through a wise combination of mental,
measures. Common sense as well as su

Positive psychological encouragem
when assisted by demonstrations through
that locomotion is possible. The coöpe
secured, the progress under massage, ele
rapidly. The whole attitude of the surg
and inspiring.

While cases of hysterical paralysi
cured by suggestion or hypnotism, yet
thorough as in the cases where both p
been harmoniously employed. The pa

[1] Concussion Spinal Cord, Willard and Spil
[2] Lovett, Amer. Med., Nov. 30, 1901; N. Y

vinced that recovery is certain. Self-reliance and perseverance must be thoroughly impressed upon the mind.

PARALYSES, REFLEX.

This term is often applied to paralysis where the cause is undetermined. A methodical and thorough examination will usually discover the true reason for the deficiency of muscular and nerve power. The author recently saw a peculiar uncertainty of gait in a patient of highly nervous temperament. The condition followed a severe injury about the hip a year previously and was unconnected with any bone injury, as was proved by the X-ray and by clinical symptoms. The sciatic was not involved and no lesion could be discovered until the patient was stripped, when the moment that locomotion was attempted, the gluteals in the buttocks and about the hips were thrown into marked vibratile contractions.

Circumcision has been performed on hundreds of boys for so-called reflex paralysis, when the real condition has been undiagnosed. While retained smegma and contracted prepuce will undoubtedly be found in many cases with various reflex symptoms, yet the removal of the fold will but slightly benefit the symptoms until the real exciting cause is sought and discovered (p. 201).

NEURITIS.

Neuritis is a not uncommon cause of deformities in children from loss of motor power and atrophy of certain muscles. The hyperemia may be interstitial or parenchymatous in the nerve-fibres or in the surrounding connective tissue.

The causes are numerous, injury being the most common. Joint diseases and septic infections, fracture callus, sudden exposure to cold, exhausting or septic disease, and metallic poisons are a few of the causes. Neuritis of the little finger from prolonged resting of the ulnar nerve at the elbow upon a mattress during a long illness, is sometimes encountered and the effects may be lasting (p. 567). Tearing or sprain of the spinal ligaments, especially in exhausting diseases, may result in a fibrositis or perineuritis that will permanently impair certain motor and sensory regions in the lower limbs and render locomotion uncertain and feeble for months or years (p. 453).

The irritation of a distant peripheral nerve is illustrated in the reflected pain at the inner condyle of the femur in tubercular hip disease and in the abdomen from spinal caries. The pain in neuritis is often felt chiefly in the peripheral nerves beyond the point of injury or of pressure. When a sensory nerve is involved, the pain in arm or leg may be dull and aching or itching, darting and remittent. Local tenderness is often combined with numbness, impaired nutrition and trophic changes. When a motor nerve is involved, irregular contractions, feebleness, paralysis, atrophy and deformity result.[1]

A brachial neuritis from forcibly lifting a child by the arm will give pain, intermittent or continuous, sudden in onset and increased by raising the arm. It may be felt over the area of the suprascapular nerve or in the

[1] S. Weir Mitchell, Injuries of Nerves, 1872.

shoulder or down the arm with tenderness over the injured nerve. Deltoid weakness is common after contusion of the circumflex.

Diagnosis.—Anterior poliomyelitis in its febrile stage may resemble neuritis in its tenderness of muscles but the speedy appearance of paralysis soon indicates the real trouble.

Treatment.—The deformities arising from neuritis may require surgical interference as will also the pressure causes of callus, cicatrices, exostoses, and malignant growths.

Trophic changes have not been greatly benefited by nerve stretching.

In severe pain in the peripheral nerves a constricting band in the nerve sheath may be divided and adhesions of fibres broken up by forcible injections of saline solution between the sheath and nerve.

Local treatment will include rest by splints, sling or other means, and the application of dry or moist heat. Pain can be relieved by the application of equal parts of chloral hydrate and camphor, also by the therapeutic use of the high-frequency current, sometimes by the X-rays. Hypodermics of strychnine, chloroform or osmic acid in one per cent. solution have proven beneficial. Rheumatism, syphilis and other constitutional conditions should receive proper attention. Massage must be cautious and gentle at first. Apparatus is often necessary to prevent foot-drop or other deformities. In lead palsy at the wrist, a brace to prevent stretching of the extensors is valuable until constitutional measures have expelled the poison (Fig. 510, p. 571).

PSEUDOHYPERTROPHIC MUSCULAR PARALYSIS.

Synonym: Lipomatous muscular atrophy (improperly called Duchenne's paralysis).

A form of paralysis occurring in early childhood and characterized by apparent enlargement of certain muscles, with atrophy of other groups, progressive feebleness and finally helplessness, is known as pseudohypertrophic. It is really a progressive displacement of muscular fibres by fatty particles (Fig. 589).

FIG. 589.—Pseudohypertrophic muscular paralysis with enlargement of calf muscles. Inability to walk erect.

Etiology.—Except for heredity, no cause can be assigned. The author has seen it in three successive generations and several members of a family may be affected (Fig. 590). It is ordinarily not observed until after the child begins to walk, but may come on in adolescent or adult life. Males are more frequently affected than females and the disease seems prone to descend through the maternal side. This may be accounted for by the fact that a mother not infrequently transmits her qualities and disposition to the boys of the family. There seems a tendency, other things being equal, in father or mother to produce the opposite sex.

Pathology.—The connective-tissue and fatty elements are increased, thereby enlarging the limb, while muscular fibres are replaced by fatty deposits.

Symptoms.—The child will be late in attempting to walk and will then stagger, throw his feet wide apart and fall easily, will lordose his lumbar spine and throw his shoulders back to maintain equilibrium. When creeping and sitting, the muscles of the back are so feeble that normal positions are not secured. Notwithstanding the apparently large legs, the gastrocnemius will slowly diminish in power while increasing in circumference. The latissimus dorsi and pectoralis major may atrophy while the infraspinatus may hypertrophy. The weakened spinal muscles permit the pelvis to fall forward to a right angle with the femora and extreme lordosis results with increasingly difficult and finally impossible locomotion. Electric excitability and the reflexes are lost. Mental dulness is common.

FIG. 590.—Brothers with hypertrophic enlargement of calves of legs.

Diagnosis.—With child stripped of all clothing and locomotion carefully observed, the diagnosis from extensive infantile spinal paralysis, from spastic and other forms of paralysis, or from rickets, is not difficult.

Prognosis.—The condition usually progresses slowly for years to complete helplessness, with the prospect of death from some intercurrent disease.

Treatment.—Massage, electricity and gymnastic muscular development may retard the disease. Contractions at the ankle and knee should be tenotomized to prolong the walking powers of the patient as long as possible. A spinal corset or brace for the lordosis will give assistance (Fig. 219, p. 279). Thyroid extract has little or no effect.

HEREDITARY ATAXIA.

Synonyms: Hereditary ataxic paraplegia; degenerative ataxia (improperly called Friedreich's ataxia).

An ataxic paraplegia with weakness and incoördinate movements first of legs then of arms, coming on in children about puberty, is due to a sclerosis of the posterior columns and crossed pyramidal tracts of the cord similar to the lesions of locomotor ataxia. Neurotic, alcoholic, syphilitic or tuberculous parents are liable to impart this condition to one or more of their children. It may follow the infectious fevers of childhood and be accompanied with uncertainty of speech, loss of reflexes and deformities. The treatment is practically the same as in locomotor ataxia: improved hygiene, tonics, massage and electricity. If the feet become distorted, tenotomies will increase the power of locomotion.

ACUTE ASCENDING PARALYSIS OF CHILDREN—Landry's paralysis—begins in the legs and rapidly ascends.

PROGRESSIVE MUSCULAR ATROPHY OR DYSTROPHY.

Synonyms: Wasting palsy; atrophic paralysis; Cruvelhier's atrophy; Duchenne's paralysis.

This form of paralysis is characterized by a progressive wasting of certain groups of muscles, with decreasing power, atrophy and deformity, often extreme and disabling.

FIG. 591.—Progressive muscular dystrophy.

It is most frequently seen in children of neurotic and consanguine parents. In the myopathic or distinctly muscular form, known as MUSCULAR DYSTROPHY, the muscles of back, arms, shoulders and face are primarily affected (Fig. 591). In the myelopathic form in adolescents, the disease differs from the muscle paralysis of lead or other metallic poisoning, although often commencing in the smaller muscles of the hand and wrist it extends steadily upward toward the trunk. In the peroneal type deformities similar to those of anterior poliomyelitis are not uncommon.

Neurologists recognize the Aran-Duchenne, the Erb, and the Landouzy-Déjerine types.

Diagnosis.—The diagnosis may be confused with anterior poliomyelitis, lead poisoning, neuritis, etc.

Prognosis.—Unfavorable.

Treatment.—Tenotomy of contracted muscles will prolong the powers of locomotion. Hypodermics of strychnine into the muscles, galvanism, faradism and massage may retard the advance of the atrophy.

PARALYSIS, AMYOTROPHIC LATERAL SCLEROSIS.

This condition is a disease in the lateral columns sometimes involving the anterior cornua and is difficult to diagnose from the degenerations found in multiple sclerosis and syringomyelia.

Treatment.—Electrotherapy and massage and salt bathing are helpful. While ankle clonus and spastic calf contraction are absent, the knee-jerk is usually increased. Cramp-like seizures in the calves are common.

MYOTONIA CONGENITA—THOMSON'S DISEASE.—Congenital myotonia consists of a spasmodic tonic rigidity of muscles lasting for a few seconds, then followed by relaxation and voluntary control of action. During the period of spasticity the patient is unable to relax his grasp upon an object. The condition is sometimes hereditary, twenty cases having appeared in four generations of one family.[1]

The condition may be somewhat benefited by systematic muscular training in a well-regulated orthopaedic gymnasium.

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[1] N. Y. State Jour. Med., Dec., 1907; Medical Times, New York, Feb., 1908.

CHAPTER XXVII.

TALIPES (*talus*, ankle; *pes*, foot)

Synonyms: Club-foot, reel-foot; talipes equinus, varus, valgus and calcaneus; Klumpfuss, Pied-bot

TALIPES is a generic name for the different varieties of club-foot but the latter term is used by the laity to designate equinovarus, in which variety the patient walks upon the outer side of the foot with the toes turned inward. The mediotarsal joint, the juncture of the calcaneocuboid and astragaloscaphoid articulations, is the region at which the lateral

FIG. 592.—Deformity of bones of feet at mediotarsal joint produced by walking with feet in varus position. Tarsus wedge-shaped and astragalus twisted.

deformities of varus and valgus take place. Fig. 592. The anteroposterior deformities, equinus and calcaneus, occur at the ankle-joint proper.

The four principal varieties of club-foot are: 1. Talipes Equinus: the foot nearly in line with the leg and patient walking on tip-toe, the natural position in the horse. Fig. 593. 2. Talipes Calcaneus: the opposite condition, or walking upon the heel with foot dorsiflexed. Fig. 594. 3. Talipes Varus: the anterior foot inverted and adducted, so that the patient walks upon the outer border. Fig. 595. 4. Talipes Valgus: the opposite condition, in which the anterior foot is everted and abducted, the weight in walking being thrown upon the inner border of the tarsus. Fig. 596.

Compound varieties: Equinovarus: plantar flexed and inverted (Fig. 597). Equinovalgus: plantar flexed and everted (Fig. 598). Calcaneovarus: dorsiflexed and inverted. Calcaneovalgus: dorsiflexed and everted (Fig. 566, p. 628).

Less common varieties are: Talipes or pes cavus (arcuatus, or hollow-foot) with plantar arch exaggerated (Fig. 599). Talipes or pes planus: plantar arch depressed as in flat-foot (Fig. 641, p. 698).

FIG. 593.—Talipes equinus, with projection of head of astragalus and with weight of body borne upon the toes.

Causes.— (1) Congenital; (2) acquired from paralysis, traumatism, etc.

1. CONGENITAL CLUB-FOOT.—Talipes occurs in about one in one thousand births; some authorities make it one in two thousand. Congenital club-foot is found about one-third as frequently as the ACQUIRED form. The CONGENITAL deformity is more common in males than in females and both feet are affected as frequently as one. The equinovarus deformity supplies 80 per cent. of congenital varieties, and valgus and calcaneovalgus 10 per cent. more. Simple equinus and calcaneus are rare congenitally. Occasionally other deformities as club-hand, spina bifida or bone deficiencies, harelip, cleft palate, etc., are associated.

Various theories have been evolved to explain the existence of congenital club-foot, but none of them have been proven.

HEREDITY has an undoubted influence in the production of the deformity, and the taint often extends through several generations (Fig. 600). Marriages of kin are followed by deformities twelve times as frequently as in normal unions.

FIG. 594.—Talipes calcaneus, with projection of the os calcis and elevation of the anterior part of the foot.

INTRA-UTERINE RESTRAINT from pressure, amniotic diseases, bands and interlocking of feet are suggested as possible causes.[1] The fact that inward rotation of the feet is the normal condition in early embryonic life has led some investigators to believe that a failure of the limbs to rotate through the regular succession of fetal positions has been the occasion of the deformity. While this theory of ARREST OF ROTATION is not proven it may be reason-

[1] Young, Orth. Surg., 2d Ed., p. 768; Whitman, Orth. Surg., 3d Ed., p. 757; Eschricht, Deutsch. Klinik., 1851, No. 44; Berg, Arch. of Med., N. Y., Dec., 1882; Bissel Hagen, Die Path. und Therap. des Klumpfuss, 1899, Heidelberg; Scudder, Bost. Med. and Surg. Jour., Oct. 27, 1887.

ably inferred that any interference or constriction of the limbs during intra-uterine life will result in deformity, the degree and severity being extreme when the inhibition has taken place during the early months of pregnancy. A more reasonable theory would seem to be that INTRA-UTERINE TRAUMATISM from abdominal blows, or even from a violent coition during the first month while the ovum is plastic, has resulted in such injury to the embryo's central nervous system that controlling or GOVERNING POWER of FORMATION has been practically lost and that muscular weakness or irregular contraction has followed, or that some arrest of development has occurred. Weakness of certain muscle groups and too vigorous contraction of others are often positive at birth. SERIOUS FRIGHT, great nervous shocks or lightning strokes may in the same way affect nerve supervision of fetal formation. It is in this way alone that maternal impressions during the early months could affect development; all other reports of maternal impressions are vague and exaggerated (p. 229).

FIG. 595.—Talipes varus, with inversion of the front portion of the foot with weight of body borne on outer sides of feet. Great deformity at the medio-tarsal joints and with calcaneum twisted.

Diagnosis.—Diagnosis in the congenital variety is not difficult, the only question being as to the extent and rigidity of the deformity and its effect upon prognosis.

Prognosis.—The probability of a complete functional and cosmetic cure of a case of congenital talipes will depend upon the degree of deformity, the flexibility of the foot, the age at which treatment is commenced and the perseverance of the surgeon, mother and nurse. The ease with which temporary rectification can be produced is a reliable guide as to the time required and as to the difficulties that will be encountered. Every case of congenital talipes could be entirely cured if the deformed foot could be continuously controlled in normal position by a human hand during the stage of rapid growth in the first months of life. As this is impracticable, the treatment should approach as nearly as possible to this most desirable method. With manipulation and proper treatment commencing at birth, ordinary infantile cases should be practically cured in the first year with full functional results. When treatment has been delayed, moderate cases of deformity

FIG. 596.—Talipes valgus of left foot with weight bearing upon the inner border of the foot, and prominence of inner malleolus.

can be made functionally perfect in degree corresponding to the amount of distortion, rigidity and muscular disability, and in response to long-continued manipulation, muscular, mechanical and operative treatment. Adolescent and adult cases can be made by operative treatment to walk on the soles of their feet, but function will be impaired.

FIG. 597.—Talipes equinovarus with heel elevated and twisted. Bursal cushions on outer border of feet, and soles contracted from walking. Fibula rotated on long axis and lying behind the tibia.

FIG. 598.—Talipes equinovalgus with ligaments on inner side of ankle and tarsus stretched and toes distorted.

FIG. 599.—Talipes cavus with contraction of plantar fascia and arching of sole. Tendo-Achillis too short, producing equinus.

As has been stated, a large element in cure lies in the attention of the orthopaedic surgeon to every detail of treatment, from the day that the deformed child is born until it is able to walk upon the sole of the foot with normal or nearly normal movements of the ankle and with muscular control restored. This plantigrade position must be watched by surgeon and parents and daily manipulation continued after operation until the maturity of the patient. Only when the patient walks upon the sole in

normal position is the child curing himself at each step. In congenital valgic and calcaneovalgic cases, early manipulation will usually accomplish a cure without operation.

For a parent to neglect treatment "because the child was born deformed," is to throw man's accountability upon God. This deformity physically and mentally handicaps the individual from earning a livelihood (Fig. 602), interferes with social pleasures and marriage, and causes morbid psychical conditions.

Fig. 602.—Club-footed father with three children similarly deformed. (Waltsch.)

Relapses are the rule after partial or imperfect restoration and through ignorance or inattention on the part of the surgeon or parent.

CONGENITAL EQUINUS.

Anatomy and Symptoms.—Congenitally this simple variety is rare. The gastrocnemius and soleus are the muscles chiefly contracted and can usually be stretched in infants by manipulation.

CONGENITAL EQUIN

This is the variety usually indicated w
is employed. The active and contracted
and posticus and the calf muscles, while t
extensors of the toes are feeble or paralyze

FIG. 601.—Club-feet must be straightened so as to bear t
the child begins to walk. Further deformity is thus preven
previous distortion.

inner and posterior ligaments are shortened
is held in adduction, supination and plant
is scarcely palpable. The astragalus is di
while the upper articulating face is subluxa
calcaneus slopes inward.[1] The tarsal bo
shaped when the deformity has occurred in

FIG. 602.—Walking with feet in the reel-foot position is awkward and difficult.

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club-foot the bones of the leg become rot
the fibular malleolus lie behind the tibia.
lated inward from the tarsus, every bo
with dense contractions of fascia and lig
and cold and the feet short and poorly n

[1] Frozen sections, Nichols, Bost. So

and inversion at the knee and hip are common. Even in extreme deformity, in neglected adolescents and adults, locomotion may be painless except for corns and callosities, but is always difficult, awkward, disfiguring (Fig. 602) and mentally prejudicial. Adventitious bursal pads of large size and callosities are developed upon the outer side of the foot, due to the intermittent pressure of walking. When the foot has been placed upon its sole, by operation, these cysts slowly disappear (Fig. 603).

Treatment.—I. Manipulative straightening and massage.

II. Mechanical:

(*a*) Progressive rectification by plaster bandages.

(*b*) Progressive rectification by apparatus.

III. Operative:

1. Immediate forcible straightening under ether.
2. Subcutaneous tenotomy of tendo-Achillis for equinus.
3. Subcutaneous tenotomy of tendo-Achillis and of tibial muscles for equinovarus.
4. Multiple tenotomies with extreme forcible manual overcorrection over a wooden fulcrum, followed by fixation, subsequent retention and manipulation. Manual force to be supplemented by instrumental leverage when necessary to secure a flexible foot.
5. Open section and lengthening of tendons.
6. Tendon transplantation.
7. Open division of contracted tendons, ligaments and fascia.
8. Tarsectomy.
   (*a*) Enucleation of astragalus; astragalectomy.
   (*b*) Wedge-shaped excision tarsectomy
9. Osteotomy.
   (*a*) Astragalus or calcaneum
10. Osteoclasis.
11. Amputation.

Congenital Equinovarus.—I. Manual Straightening and Massage. Treatment should commence *from the day of birth*, since in the first three months of life, bones and cartilages are soft and yielding and growth is rapid.

As remarked under Prognosis, every case of club-foot could be cured with good functional motion if the member could be held in the corrected position by a human hand for six months. To approximate such a condition the foot must be untwisted by the nurse many times a day for a minute or two at a time, but not to the extent of giving the infant pain. Whenever the baby is in the lap or at the breast, the foot can be gently held in a partially corrected position without annoying the child (Fig. 604). Pressure should be intermitted as soon as the infant's face shows discomfort. The object of treatment is to induce growth and elongation of all the contracted muscles, ligaments and tissues, to mold the deformed bones and stimulate weakened muscular fibres. In addition to manipulation, persistent oil massage of the weakened muscles should be continued for months. If this treatment together with mechanical methods is thoroughly pursued, a large majority of club-feet can be rendered flexible and made capable of

being placed with the sole squarely on the f
to walk. If such a result has not been ac
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FIG. 603.—Bursal pads on outer surfaces of feet still persistent when the plaster casts were first taken off after operation, but which disappeared in a few months. Slight knock-knee.

II.
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(*a*) Progressive Rectifica
dages.—A better material is plaster of P
foot and leg, protected by a thin stock-
ing or flannel bandage, are enveloped
in narrow plaster-of-Paris bandages. At
the first application the deformity is
only very slightly corrected. In fat,
heelless feet the plaster cast should
be applied over the bent knee or it will
be readily kicked off. If the dressing
slips, a strip of Z. O. adhesive plaster
may be applied to the outer side of the
foot and ankle in varus, brought out
to be incorporated in the plaster and
attached to the leg above the knee. If
the initial end of the flannel roller is
placed upon the top of the metatarsus,
and the bandage is then carried around
the ball of the big toe and beneath the
foot, its successive turns as it winds up
the ankle and leg will alone largely cor
thin paper-like application of plaster will

The quick-setting property of gypsum renders it the most available dressing. An inserted zinc strip (p. 244) will permit the cast to be cut at the front of the ankle as soon as the plaster has hardened, the thinner upper and lower parts remaining intact, if the dressing is not to be daily removed for manipulations. Weekly renewals of this dressing, each time with friction, manipulation, cleansing and anointing of skin, together with fixation in an improved position, will in a few months permit even overcorrection.

FIG. 605. — A moderate degree of equinovarus which was benefited by manipulation and the feet made more pliable (see Fig. 606).

Theoretically this dressing is faulty from its fixation, but practically advantage is gained by the stretching of the tense tibial muscles. It is especially useful in dispensary practice, as it prevents home interference. Soiling by urine and feces can be lessened by shellacing and extra care.

When the varus has been untwisted, more attention is given to the equinus, which is corrected in the same progressive manner, several months being required for rectification.

Wolff's method of correcting equinovarus consists in making a strong plaster casing of the deformed foot and leg, subsequently dividing it across the ankle and removing wedge-shaped sections from below the outer malleolus as the foot is carried outward toward valgus. Each successive correction is retained by a thin plaster-of-Paris bandage. After rectification the patient is encouraged to walk upon the cast.[1]

FIG. 606.—Later simple tenotomies secured flexible walking feet (see Fig. 605).

(*b*) Progressive Correction by Apparatus and Splints. — A simple dressing for equinovarus can be made by carrying a long strip of zinc oxide plaster from the top of the first metatarsal to beneath the sole, then upward along the outer side of the foot and leg and across the top of the bent knee. This can be fastened by adhesive strips and bandage. The efforts of the infant to straighten the knee will result in frequent correction of the deformity.

Another simple appliance is seen in Fig. 607, where leg and anterior foot are fitted with laced bands of "printer's blanket." The gum facing with the heat of the body, will adhere sufficiently to require only moderately tight lacing. Sheet gutta-percha or gum soling will also answer. The two cinctures are connected by a rubber band of any required strength, such as is used for enclosing packages of paper. This can be worn at night

[1] Freiberg, Med. News, Oct. 29, 1892; Ueber die Ursachen, das Wesen und die Behandlung des Klumpfuss, J. Wolff, Berlin.

as well as by day beneath or over a stc
cleanliness. Manipulation can be done ı

Numerous mech
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retained in position
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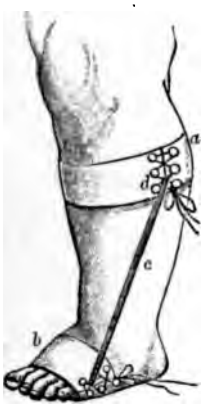

FIG. 607.—Author's simple appliance for correction of equinovarus: *a*, band of printer's blanket laced upon the calf of the leg at *d*; *b*, similar band laced upon the ball of the foot; *c*, elastic strap connecting *a* and *b*.

Among the simp
is the appliance of
sheet brass or iron
twelve to sixteen g
curved pads covered
first metatarsal and
rective counter-pressı
opposite the outer a
around the metal ba
the bar are secured b
applied first in the d
every week and proş
opposite condition o
manipulation being
splint is much
more effective for
removing the varus
than for the equinus deformity.

After the manipulations already described and the partial correction by plaster-of-Paris splints, an effective appliance for continuing correction of both equinus and varus is an apparatus extending above the knee, shown in Fig. 608. It is not subject to the irritation occasioned by adhesive plaster, and can be removed for cleanliness. The heel portion of the shoe is firmly laced in position and is provided with an everting worm screw, working by key upon a laterally moving joint in the sole, to correct the varus inversion. The laced front portion of the shoe is made upon a steel sole plate moving laterally and with a steel arch fulcrum to press upon the first metatarsal. The equinus is corrected by a screw workir project in front of the ankle-joint of the always be provided with a stop-joint at

[1] Willard, Trans. Penn. State Med. Soc., ı xlvii, 526; Simple Measures for Early Treatment Clinics, iii, 1902, 12th Series, 207.

first in the deformed attitude, removed daily for manipulation, and straightened as rapidly as the tissues permit.

Elastic Traction Apparatus.—A simpler shoe, known as the walking shoe, may be employed to correct the equinus after the varus has been untwisted by manipulation or by operation. This is shown in Fig. 609. The shoe should be open to the toes to place the foot squarely upon its sole. The heel is first secured and the anterior portion is then firmly laced. Relapse of inversion is prevented by a steel arch opposite the big toe. A steel shank in the sole holds two steel uprights with joint at ankle. From opposite the little toe an elastic strap extends to a button upon the outer upright below the knee. A pad opposite the outer malleolus prevents the outrolling of the ankle. As back-knee is so commonly a result of equinus, a stop-joint should be provided at the knee in all cases, to prevent this deformity later in walking. Instead of the elastic strap an equinus stop-joint or an elevating spring may be placed at the ankle to assist dorsiflexion. This apparatus is a useful one at any age, especially after operation. Every steel club-foot apparatus should be accurately fitted by the surgeon by the use of bending irons (Fig. 610 and Fig. 556, p. 622).

Fig. 609.—Walking apparatus after operation for equinovarus with pad at outer ankle, steel arch at ball, elastic strap opposite little toe and with stop-joint at knee to prevent back-knee.

Elastic traction can be supplied by the apparatus of Sayre, or Barwell, or by the shoe of the author.[1] In the latter, a joint movable in all directions is made by connecting a stiff heel sole and a toe sole, by a SOFT LEATHER SHANK. The posterior and anterior parts of the shoe are laced separately, the tendency of the toes to slip out being obviated by tying together the two laces at the instep. The corrective pull upon the varus and the equinus is made by an elastic strap looped to a button upon the outer upright below the knee, and attached to a strong catgut or leather cord running through an eye in a curved steel arm extending outward and forward from the stirrup (Fig. 611).

Fig. 610.—Bending irons for adjustment of apparatus.

[1] Willard, Trans. Penna. State Med. Soc., 1883, xv, 247; Therapeutic Gazette, ix, 511.

A cheap and simple TALIVERT for an infant can be made by nailing two strips of thin board in the form of an L. The padded horizontal portion being secured to the sole of the foot in the deformed position by adhesive strips, the upright portion is swung over and fastened to the back of the leg, thus by leverage untwisting the varus inversion.

A cheap and simple form of night shoe is made of wire, three-sixteenths of an inch gauge, and is capable of being bent to fit the foot and leg.[1] The foot-piece and calf band can be made of sheet brass twenty-two gauge, and the foot is held in position by encircling straps.

FIG. 611.—Author's shoe for gradual correction of equinovarus. The shank of the sole is flexible in all directions. Traction upward and outward is made by the elastic, *b*, attached to heavy cord passing through an eye in the steel arm, *a*. The elastic is attached above at *c*.

If the Chinese can greatly alter the feet of their women by bandages during infancy[2] (Fig. 155, p. 238), we can surely mold deformed feet by corrective measures applied during the first months of life.

Another form of apparatus is a steel upright with pads and straps attached to a steel sole plate which is worn inside a shoe. This brace (Fig. 627) consists of an upright, with equinus stop-joint at the ankle, permitting only dorsal flexion and is held in place by straps. This apparatus is more useful after operation than before by assisting in cure and preventing relapse.

III. OPERATIVE MEASURES.—If the deformity has not been so improved by manipulation and mechanical measures that the sole can be easily and squarely placed upon the ground by the time the infant begins to walk, operative measures become necessary, since every step in the malposition will deform the bones. Operation to place the foot at once in normal position will secure the advantage of making the child itself a corrective agent in molding the bones at each step. Earlier operation is indicated in extremely rigid feet when manipulation and mechanical treatment have failed, or when the heel is so small that no appliance can be retained, or where control of the child cannot be secured. Many an infant, sent away with specific instructions as to treatment and to return in one year, by the advice of physicians or friends has been told to "wait until it was old enough." Such advice has resulted in the delay of two, five or ten years during which time the possibility of a flexible straight foot has been sacrificed.

1. Immediate Forcible Straightening under Ether.—The molding of the foot and rendering it perfectly flexible by powerful manual or instrumental pressure produces much greater injury to both bones and soft structures than if preceded by tenotomies. A torn tendon or ligament is in much worse condition for subsequent use than one that has been cleanly divided.

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[1] Schapps, Jour. Amer. Med. Assoc., March 26, 1904, p. 829.

[2] The custom of deforming infant girls' feet probably arose many centuries ago upon the advent of a club-footed daughter into the royal household. By compelling the fashionable feet of the nation to conform to those of the deformed princess, her malformation was hidden.

2. Subcutaneous Tenotomy of Tendo-Achillis for Equinus. — The substitution of the simple, rapid and effectual operation of aseptic tenotomy for the painful, long-continued and inefficient mechanical treatment is the method to be employed as soon as the walking age is reached.

Simple subcutaneous tenotomy of the tendo-Achillis is sufficient in equinus and also in equinovarus if the varus has been cured by previous treatment. In the majority of cases, however, it is better to divide the tendons of the tibialis anticus and the tibialis posticus to prevent relapse.

Even in the simplest tenotomy, every aseptic precaution should be taken as to hands, instruments and patient's skin. In emergency operations painting the skin with iodine will yield good results. For a tenotomy

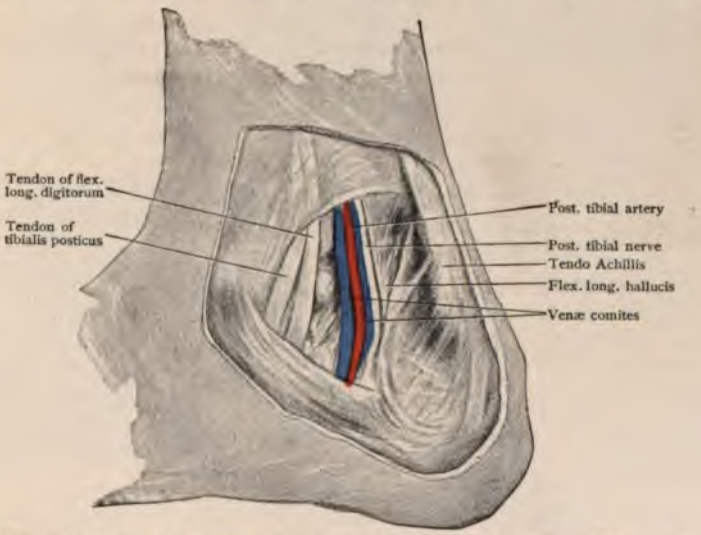

FIG. 612.—Tendons, blood-vessels and nerves lying behind the inner malleolus in the operation region for tenotomy of the tibialis posticus and the tendo-Achillis. (Piersol's Anatomy).

where subsequent stretching is not demanded, local freezing by ice and salt or ethyl chloride or local hypodermic pressure-anesthesia is used. When force is required, full anesthesia is necessary (Anesthesia, p. 17).

The tendo-Achillis is best divided from the tibial side to avoid the posterior tibial artery. The skin is drawn backward and a small puncture made with a sharp-pointed tenotome (Fig. 584, *A*) while the foot is held strongly dorsiflexed. This puncture is followed by a blunt probe-pointed tenotome with a short cutting face (Fig. 584, *B*) to prevent careless enlargement of the external wound. The instrument is carried across the limb, either in front or behind the tendon until its point is felt on the outer side. With a sawing motion, an inexperienced operator had better cut toward the bone so as not to pierce the skin accidentally when the tendon yields.

3. Subcutaneous Tenotomy of Tendo-Achillis and Tibialis for Equinovarus. — Anatomical points: The posterior tibial artery should be found behind the tendon of the flexor longus digitorum, the second tendon (Fig. 612). The internal plantar artery, the

continuation of the posterior tibial, is often divided in open and in subcutaneous sections of plantar tissues. As the external plantar artery forms the arch to supply the major portion of the foot, it should be avoided in plantar sections; a nick in its side may result in secondary hemorrhage or in aneurism. Behind the outer malleolus lie the peroneus longus and brevis.

The tibialis anticus, the first tendon outside of the inner malleolus in front of the ankle, is reached by a puncture just inside the anterior

FIG. 613.—Tendons, blood-vessels and nerves in front of the ankle, in the operative field of tenotomies and tendon anastomoses. (Piersol's Anatomy.)

tibial artery between the inner malleolus and scaphoid (Fig. 613). A blunt-pointed tenotome is then carried beneath the skin and the tense tendon divided toward the bone. The next tendon is the extensor longus hallucis. The anterior tibial artery usually lies to the fibular side of the latter tendon. The tibialis posticus is the first tendon behind the inner malleolus and is reached either above or below the malleolus. In infants with fat, deformed feet, it is so obscured that open division is advisable. The incision along the sharp border of the tibia should extend through the deep fascia. The first tendon lying close to the bone is lifted on a grooved director and its destination proven by traction upon its fibres before

division. The second tendon is that of the flexor longus digitorum. A gauze pad being placed over the wounds, the requisite amount of force is applied to insure complete overcorrection both of equinus and varus, especial attention being given to evert and abduct and make flexible the anterior tarsus and metatarsus until a transient valgic condition is secured. In rigid cases the temporary force required is great. Dorsiflexion at the ankle to the normal acute angle (Fig. 614) should be the standard even if the posterior ankle ligament is divided, since it is much more humane to secure an overcorrection while the child is insensible than to attempt correction[1] later by mechanical means.

FIG. 614.—Dorsiflexion of ankle that should be secured in operations for equinus and equinovarus.

The blood having been pressed from the punctures, thymol diiodide and gauze are applied and the foot fixed with gypsum (p. 244) in a slightly calcaneovalgic position. The result of such operation is seen in Fig. 615 in the patient shown in Fig. 616.

FIG. 615.—Infantile club-foot—equinovarus—straightened by operation and placed upon soles before the walking age (see Fig. 616).

4. Multiple Tenotomies with Extreme Forcible Manual Overcorrection over a Wooden Fulcrum, Followed by Fixation, Subsequent Retention and Manipulation.—This method is the one to be adopted in a large majority of cases, especially in older children who have been neglected or permitted to walk upon the deformed bones, or in cases that have relapsed. An X-ray will assist in locating the most serious bony deformities (Fig. 592, p. 663). Positive and complete rectification at the time of operation is essential or relapse will result. Every resisting tissue, tendon, fascia and ligament is divided or stretched until a flexible foot is secured. In many cases this subcutaneous section demands not only the division of the tibialis anticus and posticus (and tendo-Achillis as the final step), but also the plantar fascia and muscles from beyond the mid-line of the sole to the site of the section of the tibialis anticus. Frequently also in extreme cases, division of the internal and plantar ligaments is necessary, especially the astragaloscaphoid, and even the posterior

FIG. 616.—Infantile club-foot. Equinovarus both feet (see Fig. 615).

[1] Codivilla. Amer. Jour. Orth. Surg., Aug., 1909, p. 137; Archiv. di Ortoped., 1909, 353.

ligament of the ankle-joint (syndesmectomy). The result of multiple tenotomies and forcible corrections is seen in Fig. 617. For these extensive sections, a strong blunt tenotome with long cutting face is essential (Fig. 584, *C*). Punctures are made at several points and free divisions are required. The internal plantar artery is divided but soon retracts. The only secondary hemorrhage that the writer has encountered was in one case from a side nick of the external plantar (Fig. 618, p. 679). If the long extensor of the great toe is contracted, or if the flexors of the toes resist extension, they should also be divided. Tenotomy of the tendo-Achillis and anterior and posterior tibial tendons has already been described. This large subcutaneous section recommended is no more extensive than in the open operation (p. 684), and the healing is more rapid with less resultant scar. No sloughing should ever occur.

FIG. 617.—Results of multiple tenotomies and forcible corrections in badly deformed feet similar to Fig. 622.

Over a wooden conical block (Fig. 619) powerful lateral force is to be applied until tarsal and metatarsal articulations are so stretched and torn that the varus is fully overcome. Too rapid elongation may tear the skin on the concave side in a severe case. A Thomas-Jones (Fig. 162, p. 243) or Willard (Fig. 620) foot wrench is seldom required if the surgeon has good muscle; no instrument can have the intelligent action of an educated hand. The surgeon will work best without rubber gloves, but the assistants should be thus protected and the punctures kept constantly covered by a large thin gauze pad enveloping the whole foot. The section of the tendo-Achillis is deferred until the varus inversion has been corrected, as the tendon makes an excellent fulcrum. After the division the equinus must receive the same forcible attention until the foot is brought into an acute angle of dorsiflexion at the ANKLE-JOINT, not at the mediotarsal. Powerful pressure may be made upon the ankle to secure dorsal flexion by placing the patient on his face and then applying the power to the sole of the foot, care being taken not to tear off the epiphysis,[1] or to stretch only the mediotarsal joint while the os calcis and astragalus remain in false position. In severe cases of varus, the tendon of the tibialis anticus is transplanted to the outer side of the foot (p. 630).

Results of multiple tenotomies and forcible straightening are illustrated in Figs. 621 and 628. Figs. 623 and 624 show results in large boys.

Full dorsiflexion is difficult to secure in relapsed cases. The section of the tendon must be made at a fresh area and all tissue divided to the bone, the posterior ligament also requiring section. This ligament may be reached by a strong tenotome inserted posteriorly from the tibial side of the ligament at a level with the upper border of the astragalus (Fig. 614).

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[1] Hibbs, N. Y. Med. Jour., July 19, 1902.

Joseph Pancoast, believing that the resistance in obstinate equinus depended largely on a contraction of the soleus, separately shaved off its attachment to the gastrocnemius, allowing it to reunite at a higher level, his wonderful anatomical and surgical skill permitting its easy subcutaneous performance.

The inversion of the leg at the knee and hip should be forcibly rotated and everted, and in pronounced cases the casts can be fixed in this position

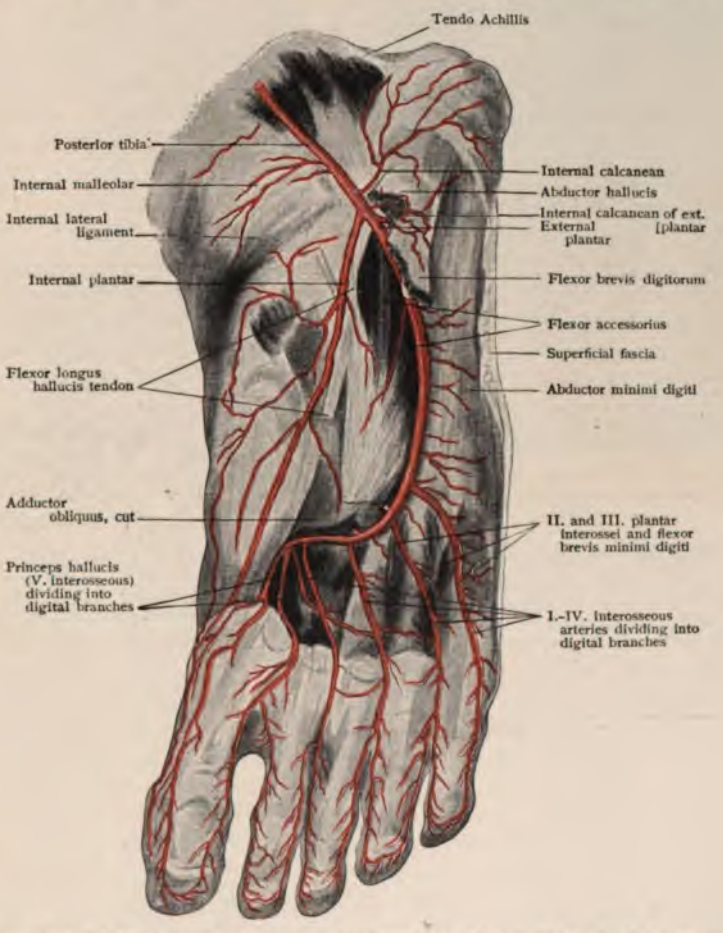

FIG. 618.—External and internal plantar arteries, branches of the posterior tibial, the external forming the main supply of the foot. The internal plantar is often divided in tenotomy of structures on the concave side of the foot in varus. (Piersol's Anatomy.)

for three weeks by wooden cross bars between heels and toes. Permanent inversion or intoeing is often due to weakness of the outward rotators at the hip, which must be developed by voluntary gymnastic exercises (p. 235). In severe cases tenotomy of the internal rotators and fascia at the hip is necessary. The everting spring of Doyle (Fig. 625) or an everting pelvic band may be used (Fig. 257, p. 304) and roller skating will prove of service. Inversion can be also lessened by forcibly stretching the

tarsometatarsal joints during operation and dressing the foot, ankle and knee in the everted position and by subsequent forcible eversions of foot, leg and thigh. If the posterior tibial tendon has been openly divided, a single catgut stitch will close the wound.

FIG. 619.—Triangular wooden block as a fulcrum for forcible straightening of club-feet after multiple tenotomies.

DRESSINGS.—Thymol diiodide (aristol) is dusted on the wounds and a thoroughly sterile dressing applied. The front of the ankle, the malleoli and the anterior part of the foot are protected by sterile cotton, and the plaster cast is applied from toes to thigh, while the surgeon holds the foot by the toes or by an everting adhesive plaster strip in a slightly calcaneovalgic position of overcorrection (p. 681). Any indentation of the fingers or crease in front of the ankle, when the plaster is hardened will produce a ridge or elevation within that may shut off circulation or produce a slough. A wooden sole plate is unnecessary if the lower surface of the cast is made thick. Great suffering often occurs from pressure beneath a cast when the preliminary removal of corns and callosities has been neglected. Shellacing prevents soiling of the cast.

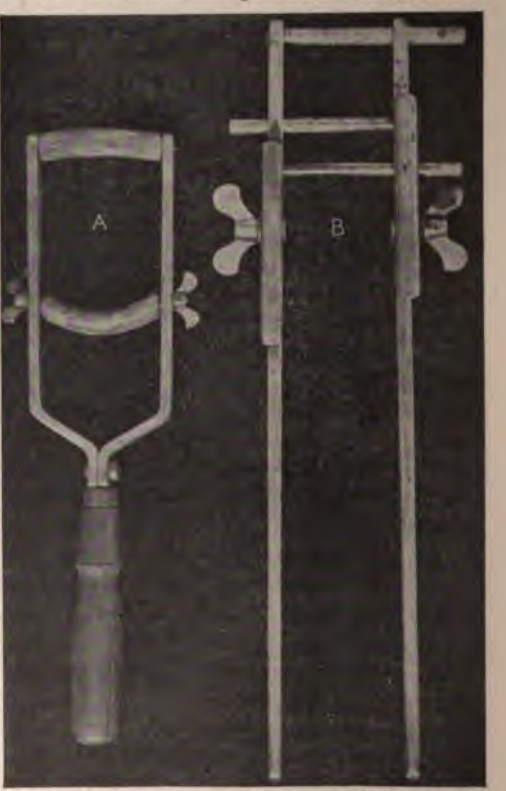

FIG. 620.—*A*, author's cheap wrench for straightening club-feet; *B*, powerful foot wrench. (For Thomas-Jones wrench see Fig. 162, p. 243.)

An inserted zinc strip (p. 244) will permit division of the cast before it has thoroughly hardened. This not only saves future labor in removal but allows spreading the gap by claws (Fig. 168, p. 248) if the exposed five toes become either too white or too blue. If swelling or pain ensue in the night the small bridges of plaster left at the top and bottom can be easily cut through and the cast slightly loosened. This absolute fixation relieves the patient from subsequent pain and is preferable to metal splints. After the third week the soles of the casts are softened by water and the patient allowed to walk upon them for two weeks.

FIG. 621.—Same feet as in Fig. 622 when straightened by operation.

FIG. 622.—Congenital talipes equinovarus straightened by tenotomies and forcible correction over wooden fulcrum (see Fig. 621).

FIG. 623.—Club-feet relapsed after simple tenotomy but straightened by multiple tenotomies and forcible manipulation.

FIG. 624.—Club-feet of severe grade rectified by multiple tenotomies and forcible manipulation.

By nitrous oxide or ether anesthetizatic
will be spared and greater flexibility secure
ing of the foot
tion. After fins
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tary and involu
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new facets hav
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are secured (Fig
of walking appl
in the shoe is sh
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and is brou
across the fron
the ankle thr
the metal loop
secured by
clasp. A stra
hold down
metatarsal con
and toes and a
ankle strap
back strap are usually required to fix the
firmly. Another form of walking shoe is
in Fig. 628.

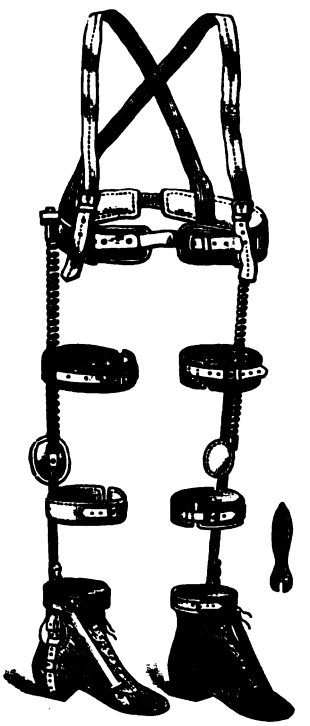

FIG. 625.—Doyle's apparatus for eversion of feet, spiral springs attached to pelvic band.

The worst cases of relapsed club-fee
those in which the surgeon considers
deformity cured by the operation and ne
later retention and muscular develop
Another serious productive cause of rela
failure to overcorrect the deformity and s
flexibility at the time of operation.
surgeon must confess to a most distr
number of failures, imperfect results
relapses, largely due to the fact that i
cases it is difficult to reshape distorted
and facets.

The former English method of dr
the foot in the original deformed posi

[1] Bradford and Lovett's Orth.

largely responsible for subsequent weak tendons. The cut ends of the tendo-Achillis may be separated three inches and yet nature will pour out sufficient reparative material to insure strong ultimate union if the foot is in fixation for three weeks. In more than a thousand sections of the tendo-Achillis by the author with immediate rectification, a weak tendon has never resulted, except in two spastic cases (p. 645).

FIG. 627.—Club-foot apparatus worn inside of shoe. (Bradford and Lovett, p. 648.)

This forcible overcorrection with tenotomies at one operation under anesthesia is much more humane than painful, long-continued failures at rectification by braces and wrenches. No case is cured that is not made flexible and capable of progression upon the soles of the feet without retention apparatus. The only safe rule of procedure is the combination of manipulations before and after operation for many years, together with the use of retention apparatus after operation and of gymnastic muscular exercises until all tendency to relapse has passed.

FIG. 628.—Walking club-foot shoe with pads opposite outer tarsus and elastic straps. For use after operation for equinovarus.

For discussion of the use of apparatus after operation see Acquired Club-foot, p. 620.

5. Open Tenotomy and Lengthening of Tendons.—Open division of the tibialis posticus tendon is advisable in young, fat infants and in relapsed cases. The tendo-Achillis may also be cut down upon and definitely lengthened by oblique division, or mortised (Fig. 568, p. 630) and sutured with chromicized gut, but this is seldom necessary except in acquired spastic equinus (p. 646).

6. Tendon Transplantation.—The transfer of contracted tendons from the concave to the convex side of the foot is not as frequently necessary in congenital as in acquired club-foot, but is sometimes helpful in relapsed cases. For Technic see pp. 630 and 647.

7. Open Division of Contracted Tissues.—The complete open section upon the concave side of the foot as recommended by Phelps is an excellent operation when the bones, as shown by X-ray, are

not too seriously deformed. The advanta
lengthens the foot. Its disadvantages are
disfiguring scar (Fig. 629) and the fact that
Its technic, after aseptic precautions and
bandage, consists in an incision from benea
downward and forward across the astrag
Through this incision tendons, muscles, fas
ing structure are divided. In old cases t
tendons of the anterior and posterior tibial
of the toes, the adductor of the great toe,
deltoid, the internal calcaneoscaphoid ligan
the ankle and the tendo-Achillis. The pow
to straighte
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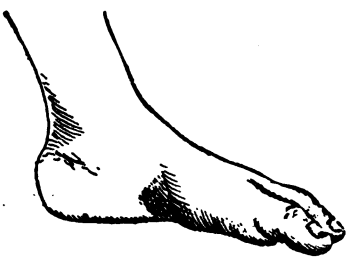

FIG. 629.—Cicatricial tissue on concave side of foot after open operation for equinovarus. (Phelps.)

Jonas advises a triangular incision to
of scar tissue which is always a disfigure

Most thorough aseptic precautions
and badly deformed foot for any operatio
be spent in removal of callosities and cor
tices or cosmoline at night. Soaking, br
soapsuds, turpentine, benzine, alcohol and
as the epithelium is always thick and der

8. Tarsectomy.—In neglected a
practically always in adults, the bones ar
from walking that some portion of the tar
operation described on page 677 will be i
not to open cancellous bone tissue, since ar
even in aseptic operations. In the abc
valuable operation, when age, time, exp
feet make relapse certain after lesser op

(*a*) *Astragalectomy.*—The most effec
cleation of the astragalus. This bone,
greatest obstacle to rectification, articulat

[1] Jones, Amer. Jour. Orth. Surg., April, 190

[2] For statistics, various operations, etc., of T
iii, 12th Series, 201, 1902; Phila. Med. News, xli
v, 225; Article on Club-Foot, Ashhurst's Internat
Soc. State of Penn., xvi, 381, xv, 247; Ther.
1896; Amer. Jour. Med. Sci., May, 1891; N. Eng

the leg and the tarsal bones. If astragalectomy is performed in single club-foot, the subsequent shortening occasions a limp. Very good ankle motion is secured in aseptic cases, as the upper surface of the calcaneum readily adapts itself to the articulating surfaces of the tibia and fibula at the ankle.

The incision for astragalectomy commences beneath the outer malleolus (Fig. 630), to save the cicatrix from future pressure. Avoiding the peroneal tendon, the incision passes forward and upward across the head of the astragalus until the extensor of the little toe is reached; the tendons and tissues are then retracted and the superior astragaloscaphoid ligament divided. If the distortion is great and search is made too far forward for the astragalus, the articulation between the scaphoid and the cuneiform bones may be opened, a fact that will be known by the three facets in place of the desired single rounded facet of the astragalus. By forcible inversion of the anterior foot the bone is then freed from tendons and anterior blood-vessels by dissection close to the bone, and the ligaments connecting it with the calcaneum beneath and with tibia and fibula above are divided.[1] The bone is best grasped and manipulated with claw forceps (Fig. 162, p. 243). Care must be taken when the internal lateral ligaments are divided that the posterior tibial artery is not accidentally nicked. A set of Reed's narrow chisels are useful (Fig. 161, *A*, *B* and *C*), in reaching the ligaments. An Esmarch bandage, though shortening the time of operation, is undesirable from its compres-

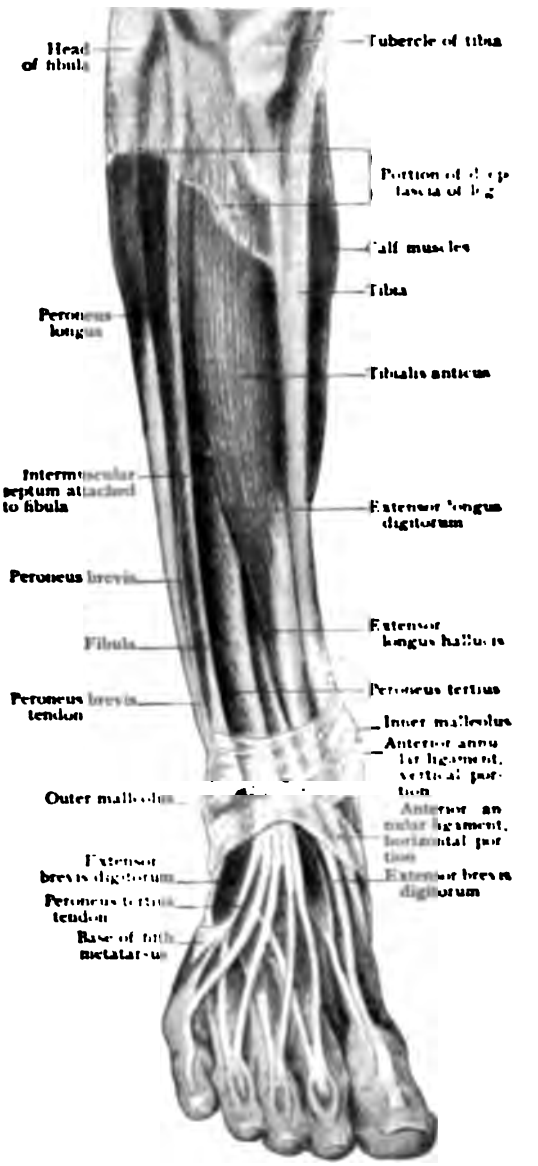

FIG. 630 [illegible]

[1] Willard, Astragalectomy, Ann. Surg., xxxvii, 1903, 637; Brit. Med. Journ., Oct. 3, 1908

sion of nerves. Forcible correction of tl must be complete. Sometimes resection o os calcis or the tip of the fibula become space vacated by the astragalus usually s without section of the tendo-Achillis. If i it may be osteotomized with benefit. Hen a half dozen strands of catgut are inserte wound is closed by catgut sutures. A ste of Paris will not need removal for sever should be commenced in the fourth we joint. If thoroughly done this operation g ankle movement, and after precautionary year, rids the patient from the necessity o

Tarsectomy is rarely necessary under in extremely rigid feet resisting other form

Results of astragalectomy are seen in in stubborn cases similar to Figs. 595 and formity.

(*b*) *Wedge-shaped or Cuneiform Tarse* moved in its entirety or by a wedge-sha including other tarsal bones.[1]

This operation shortens the foot, ope remove the chief obstacle to dorsal flex times required in adolescents in addition

9. Osteotomy.—(*a*) Simple osteo lus or of the os calcis, or wedge-shaped os operation but not as thoroughly correcti it is well to have the incision on the inne quent pressure on the scar; in valgus or also forcible overcorrection. This operati of the astragalus but does not relieve the at the ankle-joint.

(*b*) Osteotomy of the lower tibia and deformity in club-foot, but may be used tion of the leg or deformities following fi

If the astragalus is shown by the X- the tibia and fibula and that it is too wid leoli, separation of the bones of the leg l leotomy). Astragalectomy or osteotomy

10. Osteoclasis.—Osteoclasis v other osteoclast is rarely undertaken sinc 677 is far more effective. The osteocla Vulpius and others.[2]

11. Amputation.—Amputation c fiable when demanded by old and resis

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[1] For list of various forms of Tarsectomy, se Sci., May, 1891; Phila. Med. News, xliv, 650; also Trans. Amer. Orth. Assoc., vi, 159, 1893.

[2] Archiv f. Orth., vii, 23; Amer. Jour. Orth.

FIG. 631.—Result of astragalectomies in a case of severe grade of double equinovarus. Until the age of forty the man walked upon the outer borders of feet. (Photo taken four years after operation.)

FIG. 632.—Centricial line below the malleolus after astragalectomy. Good movement at ankle-joint.

FIG. 633.—Result of double astragalectomy.

FIG. 634.—Double equinovarus of high degree straightened by astragalectomies.

FIG. 635.—Good walking foot in adolescent carried after double excision of astragalus.

ulcerations or accidental operative interfe
sequent gangrene. For cosmetic reasons,

CONGENITAL TALIPES VALGUS, C
EQUINOVALG

Congenital Valgus.—Congenital valgu
is rare (Fig. 636). The acquired form of
failure to recognize a shortened condition
cussed under flat-foot (p. 698) and unde
Acquired calcaneovalgus is common after

In valgus the anterior foot is everted
tibialis anticus and posticus muscles are r
neals shortened. If calcaneus coexists, th
which act also as dorsiflexors of the ankle,
are relaxed and weakened. The dorsun
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Fig. 636.—Valgus of left foot with scaphoid resting on the floor.

I
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and paralysis (p. 628) and for flat-foo
jection of the calcaneum in the sole, tar

Congenital Varus.—This variety is
with equinus. Its treatment has been a

Congenital Equinus.—This simple
common in the compound and in the a

Congenital Calcaneus.—Simple calc
in connection with congenital valgus,
most troublesome and stubborn (p. 63

The combinations of equinocavu
valgocavus and cavus are rarely congen

All of the above deformities should be at once treated by systematic manipulation, stretching and massage, which will in the majority of cases complete a cure within a year. If persistent, they are treated by gypsum correction, mechanical appliances, and tenotomy as described under the various forms of talipes (pp. 677 and 683).

Talipes associated with Spina Bifida, with or without paralysis, occasionally develops but should be treated most cautiously, as nerve and blood-vessel supply is defective. When spina bifida occulta coexists it may be overlooked if the patient is not stripped, and failure of treatment results. Two interesting cases are reported by the author[1] (Spina Bifida, p. 444).

FIG. 637.—Walking apparatus for equinovarus with supporting pads opposite inner malleoli, and elastic straps opposite balls of toes.

Congenital Club-foot, Associated with Congenital Absence of Tibia or Fibula.—The fibula is more commonly absent or deficient than the tibia, but both bones may be involved. In many instances, other congenital deformities of feet or femurs or hands are reported with absent osseous tissues (Congenital Deficiencies, p. 747).

TREATMENT.—An X-ray will readily reveal the deficiencies. When the outer malleolus is absent, the anterior foot everts and a valgic condition results. Manipulation and straightening should commence from birth. As soon as walking begins, artificial support is given and surgical interference applied as in ordinary club-foot by tenotomy and force followed by support. When the tibia is absent, the leg is bent sharply backward with a cicatricial dimple at the tip of the bone.

Osteotomy of the tibia and straightening may give a fair, though short, walking leg, but amputation is often a better procedure, especially after the leg has attained its growth, as an artificial member may be more useful than a very short leg.

ACQUIRED TALIPES.

Acquired club-foot in its various forms is the result of infantile spinal paralysis (anterior poliomyelitis), cerebral spastic paralysis, bone disease, sprains, fractures or cicatrices, injuries at or near the ankle, and neurotic conditions. This deformity may also follow a brain hemorrhage during whooping-cough, with resultant hemiplegia, or in the equinus form may be simply adaptive, to supplement a short leg.

Equinus and equinovarus furnish one-half of the acquired cases of club-foot, valgus and calcaneovalgus one-third. Anterior poliomyelitis is the cause of four-fifths of the paralytic cases, cerebral spastic palsy supplying one-tenth.

[1] Willard, Spina Bifida Occulta, Ann. Surg., xxxvii, 457; Spina Bifida Anterior, Ann. Surg., xxxix, 612.

The distortions occasioned by weight-bearing accompanied by muscular contractions upon the one side and relaxation and paralysis of the opposing groups often result in a leg and foot entirely incapable of locomotion. The varieties of deformity will depend upon the extent of the paralysis and the attention that has been paid to the prevention of distortion following weight-bearing. Paralysis of both leg and thigh muscles is frequent. For the further discussion of the various acquired paralytic deformities see p. 616.

ACQUIRED CLUB-FOOT FOLLOWING FRACTURE OR INJURY.

The foot and ankle are often thrown into position resembling valgic or varic club-foot by fracture at the lower third of the leg, or by fracture of the tarsal bones or ankle-joint, with deposits of callus and bone. Sprains, cicatrices, or joint disease may also distort the foot at the ankle (Fig. 638).

FIG. 638.—Distortion of ankle-joint and foot after injury.

The most common deformity is the valgic variety following fracture of the fibula with tear of internal lateral ligament of the ankle. The sole is everted and the patient walks in a painful attitude upon the inner border of the foot.

Treatment.— An X-ray or palpation will reveal the point of indentation of the fibula.

Osteotomy with forcible elevation of the fibula to its normal position, with gypsum fixation of the foot in a slightly varic position for four weeks, will effectually remedy the distortion. A similar deformity, when both tibia and fibula have been broken and illy united, should be treated in the same manner, followed by hot air, massage, and muscular gymnastics.

Deformities following SPRAINS are best relieved by forcible correction under ether, with subsequent manipulations, hot air, and massage (p. 235).

Distortions following BURNS or other cicatrices usually require plastic interference; exostoses or redundant callus may be chiseled away if painful or disabling.

Distortions of the foot following TUBERCULOUS disease of ankle and tarsus are treated by tenotomies or osteotomy, with forcible correction after the tuberculous process has subsided for a year.

ACQUIRED EQUINOVARUS.

This deformity is the most common variety of club-foot, owing to the fact that the abductor and dorsiflexor group of muscles are the ones most commonly paralyzed in anterior poliomyelitis. When the peroneals and extensors are weakened, the tibialis anticus and posticus and the calf muscles being unopposed fix the deformity, and the patient, walking upon the anterior outer side of the foot, soon deforms bones and ligaments as in the congenital form. Back-knee results from the effort to bring the heel to the ground, as dorsiflexion at the ankle-joint is limited (Fig. 639).

Treatment.—Prevention of the deformity is the most important portion of the treatment, as discussed on page 620 under Infantile Paralysis. This prevention should commence as soon as initial tenderness has disappeared and should consist of massage, electricity and strengthening of the weakened peroneals, with manipulation and stretching of the anterior and posterior tibials and tendo-Achillis, and of the inner concavity of the foot. Toe-drop with resultant stretching of the anterior muscles from the inception of paralysis should receive protection from the weight of the bedclothing at night. Wisely designed apparatus must be applied to prevent the slightest tendency to distortion at the ankle or knee. The parents should be warned that atrophy of muscles and limb must necessarily occur from the disease, but that such result will not be caused by the apparatus.

Fig. 639.—Back-knee as the result of club-foot and of continued attempt to bring heels to the ground.

In simple cases, tenotomy of the contracted muscles will permit the foot to be corrected, but in the severe and neglected grades, one or more of the operations of multiple tenotomies, forcible correction, tarsectomy, tendon transplantation, the technic of which is described on pp. 626 and 630, will be required, followed by the use of retentive apparatus (p. 625) and muscle development. In a leg shortened by faulty nutrition, a cork sole should be added to prevent tilting of spine and pelvis. A completely paralyzed set of abductors, with toe-drop when the foot is bare, may after operation be easily retained in position when encased in apparatus, but braces, with all their attendant pain and unending distress, are often a lifelong necessity. This fact alone should lead the surgeon to secure the utmost possible restoration and correction at the time of operation while the patient is under ether, so that braces worn afterwards will be required only to retain the improvement gained and prevent relapse. It is to rid themselves of this great affliction of apparatus that patients will sometimes beg for tarsectomy, or arthrodesis or amputation. The author is certain that an artificial foot will sometimes give greater comfort than braces, and ensure equally good locomotion while saving a positive amount of daily pain and inconvenience.

The time for tenotomy and forcible correction will be as soon as the child is unable to walk squarely upon the sole of its foot and is increasing the deformity with each step. The operations of tendon and nerve transplantation, arthrodesis, bone resections should be postponed until definite muscular contractures have taken place, but should not be deferred until bones of foot, ankle or leg are permanently deformed (pp. 632 and 636).

APPARATUS.—When a cork elevation of over an inch is required, it is wiser to place it outside the shoe and to fix the stirrup with an inserted stiff steel shank, as a paralyzed ankle needs a stable support. An inch of cork can be concealed within the shoe. The upper face of the cork should be flat to the toes, but the front of the under surface should be bevelled well upwards at the toe to prevent tripping. In paralytic club-foot it is better to have the tread of the foot as nearly normal as possible, with the heel only slightly higher than the ball. Shoes constructed for the sake of appearance, with the anterior portion of the foot dropped to a position of equinus, will answer for a strong leg shortened by disease or injury, but a paralyzed foot needs to be placed squarely upon the sole in walking. Overgaiters will conceal the steel uprights and will assist in keeping warm the poorly nourished leg. Wool, which can be picked loose each morning and adjusted between the stocking and the supporting pad, will give much relief from pressure. Curled hair soon loses its elasticity and also may work its way into the skin and cause much pain. The most serious discomfort from the use of braces arises from the corns and callosities that inevitably occur (for treatment see p. 717). The services of a clean chiropodist once a month will contribute immensely to the comfort of the sufferer. A chiropodist is as much a necessity for club-foot cases as is a dentist for the teeth.

Stumbling can be avoided by an equinus stop-joint, or by a spring, or by elastic strap (Fig. 637, p. 689). When apparatus is first applied, great caution must be exercised lest undue pressure cause ulcers and sloughs. At first the brace should be worn but an hour, then removed, reddened areas rubbed with alcohol and alum, and dusted with talcum powder. Purple areas mean danger; pressure must be relieved by bending and readjusting with bending irons (Fig. 610, p. 673); a change of one-thirty-second of an inch will often give comfort. A removable sole plate for support of steel uprights can be inserted inside the shoe.

ACQUIRED EQUINUS.

Acquired equinus is relatively more common than congenital equinus.

The acquired form may be the result of infantile paralysis of the anterior muscles with contraction of the gastrocnemius and soleus (p. 615), or of spastic paralysis (p. 644) or of various nerve conditions or traumatisms (p. 690). In paralytic cases the effect of gravity and the weight of bedclothes when lying will continually stretch the dorsiflexors, while the opposite group, being unopposed, will steadily shorten. The foot is often extended to a straight line with the leg and the weight is borne upon the anterior condyles of the metatarsals with toes dorsiflexed, causing many corns and callosities. The foot is shortened and the sole arched as in cavus.

The equinus position in walking is often assumed by patients with leg shortened by fracture or hip disease in order to restore the length and

prevent twisting of the spine and pelvis, but the foot under these circumstances rarely becomes fixed. If an equinus becomes rigid, the limb is longer than its fellow.

Treatment.—Slight cases of acquired equinus may be treated by manipulations and continued correction, but the majority of cases as they come to the orthopaedic surgeon will require operative measures.

Immediate forcible correction under ether in mild cases is serviceable, with walking upon the plantar cast for six or eight weeks. In the majority of cases, after the correction of the cavus by tenotomy of the plantar tissues and the Thomas or other wrench (p. 243), the tendo-Achillis should be divided and the foot brought to normal dorsiflexion. A shoe provided with an equinus stop-joint or with elastic support (Fig. 637, p. 689) is worn, and weakened muscles are massaged and manipulated for many months.

Acquired equinus from traumatism or cicatrices is treated upon the same principles. The author recalls a girl who persistently claimed that she could only walk with comfort on her toes. Examination of a tender spot under her heel revealed the fact that a needle had been driven in so deeply, without her knowledge, that it had been sticking in the calcaneum for months. Its removal at once cured the equinus.

Neuromimetic Equinus.—Equinus is sometimes simulated either intentionally or unintentionally. As there is always some mental or physical cause for the affection, a careful study should be made of all existing conditions (p. 657).

ACQUIRED EQUINOVALGUS

Acquired equinovalgus is in its simple form less common than equinovarus, but is often associated with calcaneus. The tibialis anticus is especially weak and the efforts of the extensor longus hallucis to aid in maintaining equilibrium often result in hyperextension of the great toe.

In slight and undiscovered shortening of the gastrocnemius and soleus, many valgic feet have their origin, the foot being arrested in walking at or before it reaches a right angle with the leg. The strain of forward propulsion is thrown upon the tarsal joints and ligaments and a weakened tarsus results, with stretched plantar ligaments and scaphoid prominence (Flat-foot, p. 697).

In examining such a foot, an error often occurs in diagnosis, from the fact that the foot, through undue tarsal motion and abduction, appears to dorsiflex to the right angle, while the calcaneum is still plantar flexed. This error will be obviated by examining the foot in inversion, not abduction.

Steel pads at the inner ankles and elastic straps to maintain position will be required after operation.

Treatment.—The deformity should be treated by manipulation, as described under Flat-foot (p. 701) and Paralysis (p. 618). Fixation in the opposite varic condition, tenotomy, tendon transplantations, with arthrodesis of the astragalus and scaphoid articulations, as described on p. 628, are especially useful operations.

The slight contractions of the calf muscles noted above should be treated by tenotomy of the tendo-Achillis, not by ill-judged attempts to further stretch the already weakened tarsal ligaments (p. 706).

ACQUIRED TALIPES CALCANEUS, CALCANEOVALGUS, -VARUS AND -CAVUS.

The severe paralytic and neglected cases present most difficult problems for the orthopaedic surgeon (Paralysis, p. 624). The paralysis of the calf muscles permits the os calcis to drop until it becomes in straight line with the leg, is markedly enlarged, with shortening of the sole—cavus—and elevation of the anterior foot. If adductors or abductors are also paralyzed, calcaneovalgus or calcaneovarus result (Fig. 566, p. 628).

Treatment.—Prevention by manipulation, stretching, massage and electricity is all important, but if the calf muscles are entirely paralyzed and the dorsiflexors active, deformity is certain. A high heel of cork inside the shoe, or of leather outside, will assist in improvement of tread (Fig. 199, p. 266).

A brace that will limit dorsiflexion by a calcaneus stop-joint or by fixed ankle-joint is helpful.[1] When a calcaneus stop-joint is employed, the strain of the forward leg-tread is very great in walking and the base of the stirrup must be strongly forged so that it shall extend backward into the heel and forward toward the balls of the toes.

Operative Treatment.—Shortening of the Tendo-Achillis.—An operation usually known as Willets', consists in dividing the tendo-Achillis obliquely, then shortening, overlapping and suturing it while the foot is held in the position of equinus after tenotomy of the dorsiflexors. If the gastrocnemius is entirely paralyzed a transplantation of any active available muscle should be made to the shortened tendo-Achillis. An arthrodesis of the ankle and tarsus, as described on p. 628, is the better operation. In valgic cases the transplantation of the tendon of the extensor longus hallucis to the periosteum or under surface of the scaphoid (p. 632) will also assist. In varus the tibials may be transferred. Neuroplasty may also aid (p. 636). Whitman proposes a combination of arthrodesis, backward displacement of the calcaneum and tendon shortening and transplantation.

Calcaneocavus, Acquired.—Jones[2] advises an operation in two stages, one month apart. The cavus and valgus are first corrected by removing a wedge with base at the dorsal aspect of the tarsus, after division of the plantar fascia. The cavus is then forcibly straightened and fixed in a cast in dorsiflexion in line with the deformed calcaneum. At the second operation the ankle-joint is opened from behind, a wedge removed from astragalus and the tibia and fibula denuded of cartilage. The foot is brought to a right angle and immobilized until union is complete, then fixed with a splint for a year. If the gastrocnemius has retained power, the tendo-Achillis may be shortened.

Calcaneovarus is rare, but if present is to be treated on the same general principles.

Acquired calcaneus from cicatricial contraction may be corrected by triangular flaps of skin cut from the front of the leg, or from the opposite limb (Fig. 144, p. 220).

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[1] Whitman, Amer. Jour. Orth. Surg., Aug., 1909, 98.
[2] Jones, Amer. Jour. Orth. Surg., April, 1908, 371.

ACQUIRED TALIPES CAVUS.

Synonyms: Talipes arcuatus; contracted foot; hollow-foot; improperly called non-deforming club-foot.

A high arch is often normal, but when exaggerated becomes a source of much discomfort. A normal high arch may readily be converted into a hollow-foot by the use of high-heeled shoes, or by excessive use of the gastrocnemius in professional dancers. Its most serious types are met with in spastic cases, where the weight is thrown almost entirely upon the anterior metatarsal condyles, the toes standing upward almost at right angles to the foot,—equinocavus. Atrophy of the plantar tissues with tenderness and painful callosities on the sole and corns upon the toes will seriously disable the sufferer. Combined with these deformities will be a contraction of the calf muscles, limited dorsiflexion at the ankle, with the consequently increased weight upon the metatarsals in walking. Locomotion will be awkward and painful and a variety of nerve symptoms resembling those of anterior metatarsalgia and of flat-foot will be present. The condition may be a temporary one, especially in neurotics after sprains. The effect of a shortened tendo-Achillis as a cause of flat-foot and pes planus is discussed on p. 697.

The gastrocnemius may also be contracted after a slight and perhaps unrecognized anterior poliomyelitis or a neuritis. Other extreme cases of acquired hollow-foot are found in paralytic talipes calcaneus in adolescents and adults, when continued walking has carried the posterior os calcis into almost a straight line with the leg, the contraction and atrophy of sole being marked (Calcaneocavus, and Spastic Paralysis, p. 641).

The so-called non-deforming club-foot is clearly a misnomer, as the condition is both deforming and disabling. The term should be applied only to slight and temporary cases of talipes equinocavus due to nerve irritation, sprain or spasticity.

The gastrocnemius will be so contracted that the foot can with difficulty be brought to a right angle with the leg when knee and foot are held straight. The plantar fascia becomes tense and tender, and cramps and pains in the calf and foot are common, the gait is awkward and the patient easily fatigued. The condition may be mistaken for metatarsalgia, sciatica, neuritis, rheumatism or ostitis. In the majority of cases the nerve element predominates. Other results are dorsal extension of toes, hammer-toes and corns and callosities opposite the plantar, metatarsal and phalangeal articulations.

Treatment. In young and flexible cases, slight benefit may result from forcible manipulation. A plantar splint with adhesive plaster or with buckle and strap over the high instep will assist. In cases of pure hollow-foot mechanical screw pressure under ether is allowable to break down the arch.

Well-established cases of hollow-foot with contraction of the calf muscles will require tenotomy of the tense plantar fascia, of the tendo-Achillis and of the extensors of the toes. After division of all the contracted plantar fascia and muscles, powerful force over a narrow wooden block (Fig. 619) will be required to lower the arch and stretch the plantar tissues. A foot wrench (Fig. 620, p. 680) may be required to give addi-

tional power. The tendo-Achillis should not be tenotomized until the end of the operation, but should be used as a fulcrum during manipulations. The ankle joint should be fixed in plaster until the tendo-Achillis has united, after which walking should be encouraged. Manipulations and muscular exercises with hygienic and constitutional measures should follow.

SUMMARY OF TREATMENT OF VARIOUS FORMS OF TALIPES.

1. Congenital club-foot can be cured if treatment is commenced at birth, since during the first three months the bones are soft and pliable.

Infants, from birth to the age of walking, are treated by manipulation to secure a flexible foot, by massage, by frequently repeated and daily increasing forcible correction without giving pain, by progressive plaster-of-Paris straightening until a position the opposite of the deformed one is secured, then by retention apparatus.

2. Early operative procedures are unnecessary unless the foot is so deformed that apparatus cannot be retained, or unless the parents are unable or too careless to give the required attention.

3. If the foot cannot be placed easily and squarely upon the sole when the age of walking has been reached, operation is essential.

4. Simple tenotomy of the tendo-Achillis is applicable only to very young children or in simple equinus.

5. A large majority of moderately deformed feet in children between the ages of one and fifteen can be straightened by multiple subcutaneous tenotomies and fasciotomies, together with powerful rectification over a wooden fulcrum. Overcorrection must be complete at the time of operation. Retention, fixation and subsequent manipulation with mechanical support will complete the cure. The more thorough the overcorrection at the time of operation, the less will be the danger of relapse. In neglected or relapsed feet in adolescents additional instrumental leverage will be required.

6. Subcutaneous sections heal more rapidly than open ones and leave no scar.

7. Open section is applicable to cases where the deformity of the bones is not serious but is due to great contraction of tendons and fascia on the concave side of the foot.

8. Tarsectomy is rarely necessary under five years of age except in especially rigid feet with great bony deformity. In neglected or relapsed cases, astragalectomy becomes the operation of choice for ensuring full rectification, plantigrade locomotion, the avoidance of further relapse, and freedom from subsequent use of braces. Astragalectomy removes the chief offending bone and is simpler and better than wedge-shaped excision. If done upon one foot only, it produces a limp.

9. Acquired club-foot, from paralysis or other causes, requires prolonged gymnastic, mechanical and operative treatment (Paralyses pp. 618–626).

10. Relapses are due to incomplete correction at the time of operation, to lack of subsequent supervision by the surgeon and his failure to insist upon manipulations and prolonged gymnastic muscular exercises, or else to the carelessness of parents.

CHAPTER XXVIII.

VARIOUS SURGICAL CONDITIONS OF THE FEET.

FLAT-FOOT.

Synonyms: Weak-foot; splay-foot; pronated, abducted, everted or valgic foot; pes planus; weak ankle; projecting inner ankle; broken-down arch; talipes valgus.

From one-fifth to one-fourth of the deformities of the body presenting themselves to the orthopaedic surgeon will be from weakened tarsal arches.

Causes: Infantile.—A condition of abduction of the anterior foot with valgic deformity from protrusion of the astragalus and scaphoid and inner malleolus, without marked flattening of the arch, is common in childhood. It may be due to congenital bone formation, or it may occur in early rickets or other conditions of impaired nutrition and muscular weakness. When the child begins to walk, a slightly valgic foot is normal until the muscles assume proper control.

Fig. 640.—Pronated feet produced by shortened tendo-Achillis.

Acquired.—The most common cause of acquired flat-foot is a shortened condition of the tendo-Achillis, often due to unrecognized nerve irritation following disease, or to neurotic conditions or spastic contractions in children or adolescents. The normal foot has no elevation at the heel, the foot falls evenly upon the ground and free motion is secured at the ankle-joint. The human race has for centuries been wearing shoes with heels; even the low flat heels worn by men are unnatural. As the result of this faulty position from childhood the gastrocnemius and soleus have shortened and a race has been produced with feet easily developed into flattened arches. Flat-foot is but the exaggeration of the weak, pronated and abducted foot (Fig. 640). High heels and ill-fitting shoes, especially in working girls compelled to stand, throw the weight of the body upon the anterior foot in an abnormal position and give an insecure foundation, thus inducing both pain and disability. In the working classes, therefore, are found the most severe forms of deformity, since they are not only more subject to the above causes but are also less able to adopt measures of relief.

Fashion is the most serious obstacle to the wearing of proper shoes. Following the custom of the Chinese, a cramped unnatural position has been forced to be accepted as a thing of beauty. The supporting and propelling power of the normal toes has been entirely neglected. Eversion of the feet in walking is the position of weakness. The weight is thrown upon the inner arch, the scaphoid and malleolus are pressed out of position, rigidity follows from improper pressure on tarsal surfaces, and pain and so-called rheumatism result.

Barefooted races show the normal condition of feet and the great assistance rendered by the toes in locomotion.[1] That the toes are capable of great prehensile powers of adaptation is seen in special cases where they have been developed almost to the dexterity of fingers.

The foot has two functions: first, body support; second, locomotion. In locomotion, the final part of the step is accomplished by the calf muscles as the power, the anterior foot as the fulcrum, while the tibia and fibula bear the body weight—a lever of the third class. If the gastrocnemius and soleus are shortened, as is practically always the case in flat-foot, the normal dorsiflexion of the foot beyond the right angle (which is so essential when the rear foot is behind the body line) is checked by the taut tendo-Achillis and the entire strain is brought upon the tarsus in an attempt to supplement the limited ankle motion. In the unconscious effort to compensate for the lack of ankle-joint motion and to relieve this strain, the whole limb is everted and the foot abducted. Slow but continual stretching results in elongation of plantar and internal ligaments of astragalus and calcaneum and scaphoid, and in weakening and stretching of the anterior and posterior tibial muscles. The usual dorsal range of motion at the ankle should be from ten to twenty degrees acute; the plantar flexion fifty to sixty degrees obtuse. In pronated feet, dorsiflexion may appear to be nearly normal on account of undue tarsal motion, but if the foot is carried into adduction, and then dorsiflexed, the shortening of the tendo-Achillis will be very evident.

FIG. 641.—Flat-feet with scaphoid regions resting on the ground.

In acquired weak-foot the activities of adolescents, together with repeated sprains, or the undue weight-bearing of occupation, coupled with muscular weakness (either temporary from illness or permanent from pathological conditions), will often result in slow ligamentous elongation and lowering of the normal internal arch (Fig. 641).

Knock-knee and anterior or inbowing legs will also cause this deformity (Fig. 233, p. 291). Occupations that require long-continued standing are worse than active walking, since in the former the weight is thrown upon the ligaments, while in walking the muscles are constantly in use and weight-bearing is continually changed.

[1] Hoffman, Amer. Jour. Orth. Surg., Oct., 1905, 105.

Traumatisms.—In adults the most severe forms of tarsitis are seen after traumatisms or fracture of the fibula or repeated sprains, especially in gouty or rheumatic individuals, the rigid and painful variety sometimes resulting in total disability. Gonorrheal and other infective processes also result in painful feet (Rigid Feet, p. 705).

Paralysis.—Paralysis of the anterior and posterior tibial muscles from anterior poliomyelitis is a very common cause of the acquired form of valgic foot.

The Hebrew and the colored races have especially flat arches.

Flat-foot is often a cause for rejection of recruits for the army or navy.

Anatomical Conditions.—The explanation of the deformity is not difficult when the uses and mechanics of the foot are examined. Whitman,[1] Lovett[2] and others have most elaborately studied this subject and with excellent practical results. The condition is often one of disproportion between body weight and the ability to support it. The normal foot is suspended in equilibrium by the sling-like action of the tibialis anticus and posticus assisted by the extensor proprius hallucis upon the inner side, while equalization upon the outer side is maintained by the peroneals assisted by the outer tendons of the extensor longus digitorum. Any deficiency of power, or excessive action of either of the opposing groups will tend to alter the proper relation of weight-bearing as transmitted to the astragalus and foot through the tibia and fibula. In the normal foot the central tibial line should fall between the second and third toes; in the abducted, everted or pronated foot this weight line may fall through the line of the first toe or even through the scaphoid.[3]

The inner longitudinal arch of the foot, with its abutments upon the heel and upon the condyle of the first metatarsal (Fig. 642) is supplemented by the elastic spring of the great toe and is strengthened by the plantar fascia, the plantar flexors and the strong plantar ligaments. The fifth metatarsal supports the outer arch, and the whole outer border of the foot should normally rest upon the ground. As the ligaments yield, the articulating surfaces are no longer in smooth opposition but are tilted, with resultant pain and muscular cramp. From weakened muscular power, slow stretching of calcaneal, astragaloid and scaphoid ligaments takes place until both astragalus and navicular bones protrude inwardly and finally project so as even to impinge upon the ground, the arch being entirely lost (Fig. 641).

The pronated foot or weak ankle differs from the flat-foot in the fact that the arch may not be altered, although the anterior part of the foot is abducted and the inner malleolus may be prominent. The weak foot is not necessarily flat, but is valgic.

Symptoms. A young child will be brought to the orthopaedic surgeon usually because the mother has noticed a projection of the inner malleolus, with wearing out of the shoes opposite this point or upon the inner borders. He has weak ankles and complains of fatigue after even a short walk. For examination such a child should be stripped so that feet, ankles, knees,

[1] Whitman's Orth. Surg., 3d Ed., p. 665, et seq.

[2] Bradford and Lovett, Orth. Surg., 3d Ed., Flat-foot, p. 612.

[3] Dane, Trans. Amer. Orth. Soc., 1897; Lovett, Trans. Amer. Orth. Assoc., vol. viii, 78.

hips and back can be carefully observed. tion of hips will frequently be discovered. walking, standing and sitting. Standing weight bearing upon the feet is noted, the upon the inner side, the outrolling of the of the foot. Older cases will complain c comfort and pain while standing, and lat pain in foot or leg or thigh often attribut rium is destroyed, and the strain on the po on the spine results in most persistent bac pelvic disease. The pain will vary from s ability, even to the use of crutches or to co discomfort and disability is not always in

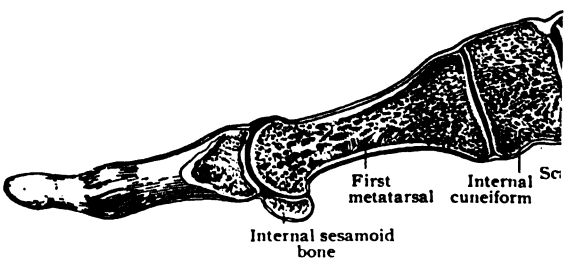


FIG. 642.—Inner arch of foot supported by calcaneum

formity. A low arch need not necessaril the contrary, extreme discomfort may re step. Tenderness over the insertion of th upon this muscle. Inability to dorsiflex f due to spastic or other contraction of the ling awkward gait, especially in running, everted feet.

Though rest relieves pain it may cc rising in the morning. Various condition rheumatism, neuralgia, etc., will ordinari ened arches.[1] An examination of old w strate the habitual tread. Dorsiflexion sh and with foot both adducted and abducte spasm, especially of the peroneals, impair perspiration and disability, are described t tarsalgia, lateral curvature and stoop sh

[1] Vanderveer, Jour. Med. Soc., N

An imprint of the tread may be made by wetting the sole, or by powdered chalk or any white powder on smoked paper, or by vaseline, or better, by observation upon a glass table with sloping mirror beneath (Fig. 643). Such a mirror will clearly show the whitened areas on the soles from weight bearing[1] (Fig. 644).

Diagnosis.—Diagnosis is often difficult, as so many other causes of painful feet exist. The systematic examination of every painful foot is important. Feet, legs, knees and body should be bared. Such an examination will frequently reveal a lowered arch or a pronated condition and demonstrate one of a dozen other peculiarities. The gait, the tread and position of the foot, the amount of flexion and extension, tenderness, muscular rigidity and contraction, bone deposits, achillodynia, bursal inflammations, etc., all require consideration. Anterior metatarsalgia, plantar neuralgia, hammer-toes, painful heel or sole, gonorrheal exostosis, corns and callosities may be mistaken for flat-foot. Arterial sclerosis or intermittent claudication will give similar pains. The rigid tarsus following traumatism or rheumatism will be noted under Rigid Flat-foot.

Fig. 643.—Soles of feet seen standing on glass plate with sloping mirror beneath (Young).

Prognosis.—In simple cases, a cure may be expected under proper treatment. Even in extreme and rigid cases, great benefit will result from radical measures as discussed under Rigid Feet (p. 706).

Treatment.—The treatment of weak-foot may be divided into the MUSCULAR, MECHANICAL and OPERATIVE measures.

Muscular.—In all cases it is important to instruct the patient as to the proper method of standing and walking. The weight of the body should be thrown upon the outer border of the foot and walking encouraged with the feet straight forward or even in the inverted and varic position.

Great comfort can be secured by hot-air baking but no permanent cure can be made until the weakened muscles have assumed their proper equilibrium of control. The first step, therefore, is to develop the anterior and posterior tibial muscles by massage, electricity, hot and cold douchings and voluntary gymnastic movements. The foot must be persistently and frequently drawn by the patient into the adducted or varic position, and the flexors of the toes contracted. Tip-toe walking, with the major portion of the weight thrown upon the fifth metatarsal and toe is to be used whenever the patient is barefoot or in stockings.

In very young children—where coöperation cannot be expected—great

[1] Young, Amer. Medicine, Sept., 1902.

benefit will result from massage of the tib
inversion and adduction with dorsal flexio
upon the scaphoid and astragalus. As soc
plays may be introduced. Voluntary addu
ing to a slipper by an elastic cord, a large
in diameter. Forcible and repeated striki
by the action of the adductors of the foot
ment as a return ball (Fig. 653). Anothe
and adductors can be simply made by a
slipper, a cord running over a pulley whe
appliance repeated contractions of the tibi
in raising this weight.
weight may be used. In
gymnasium the foot m
circumduction, and the
and diversion (Gymnasiu

Fig. 644.—Temporary pallor from pressure on sole of foot as seen through a glass plate supporting the body. (Piersol's Anatomy.)

In older cases the
voluntary circular moven
increase the muscular mo
ing of the peroneals with
of the scaphoid with dor
an instructor. Adductio
employed. In painful ca
frequency current or the
night shoe fixing the fo
sleep are useful. The ge
attention in adolescents
fined at school.

Adhesive Strappin
given by long zinc oxi
passing from the outer s
and foot, up along the in
applied while the foot is l

Mechanical Treatment. — Mecha
sidered as a temporary necessity while n

Sloping Sole.—In all cases of weak-f
important to alter the tread, to throw t
border of the foot instead of the inner
leather insole can be made one-sixteent
thicker than the outer border by inserti
of the heel and beneath the ball of the
walk, this sloping sole is much more ef
"weak-ankle supports." For support of
a slight leather elevation of this sloping
inner arch to raise and support the scap
can be made removable or can be more
flat heels, with inner side prolonged b
shanks, stiff counter prolonged far forwa

[1] Ochsner, E. H., Jour. Amer. Med.

along the inner borders (Fig. 646) and sloping outwardly are essential. The great difficulty in curing this foot deformity lies in the averseness of the ordinary girl to proper footwear. Moccasins or straw-soled slippers are better than shoes and may be worn indoors. Cooke[1] has devised a cast upon which a shoe can be built without a wooden last. The shoes should not only slope so as to throw the tread upon the outer border of the foot, but should also adduct or twist inward toward the median line. The gait is of especial importance. The patient should not toe out, but should walk with feet straight forward, and when walking on tip-toe or on the outer borders of the feet, should toe inward.

FIG. 645.—Flat foot shoe with heel prolonged on inner side to support the arch.

Sole Plates.—Numerous sole plates have been invented of rubber, cork, leather, celluloid, aluminum, steel, etc. (Fig. 647). The simplest support is made of bevelled felt cloth placed beneath the centre of the arch. It may be held in position by adhesive straps or by attaching it to a thin stiff leather insole. For cases requiring still stronger support, tempered spring steel is the most reliable. After proper shaping, rusting may be delayed by coating with celluloid, vulcanite, nickel, silver, copper or japan, or by galvanizing. Phosphor-bronze and aluminum have not proven satisfactory. Hard-rolled German silver, eighteen per cent. nickel, gauge eighteen, is light, does not rust[2] and can be hammered to shape. German silver is readily worked into footplates, and may be fashioned from simple outlines of the foot without the taking of a cast. It has also the advantage, when worn, of exhibiting imprints of any faulty pressure that needs to be modified.[3] Pencil outlines of the foot and of the inner slope of the arch, taken in inversion both with and without weight bearing, may avoid the necessity of taking a plaster cast.

FIG. 646. Straight position of inner border of foot.

Taylor (R. T.) takes the outline of the foot and makes the shoe in the position of adduction, inserting a strip of spring steel from one to two cm. in thickness and from one to four cm. in width from the middle of the heel to the ball, with a stiff leather counter extending forward to the ball. This steel is stitched between the outer and inner sole.[4]

Sheet celluloid or pyroline is light, comfortable, and non-corrodible, is readily cleaned and slightly elastic. Its disadvantages are its brittleness, thickness, and lack of durability. Thickness one-sixteenth of an inch, one-tenth, and one-eighth are the usual sizes. Celluloid plates may be readily molded over a cast by softening the sheet in boiling water, then shaping and fastening it to the

[1] Cooke, Jour. Amer. Med. Assoc., 1907, 1054.
[2] Amer. Med., Oct., 1907, 577; Amer. Jour. Orth. Surg., Aug., 1908, 170 and Nov., 1909.
[3] Amer. Jour. Orth. Surg., Aug., 1908, 170.
[4] Amer. Jour. Orth. Surg., Nov., 1909, 243.

plaster mold. Celluloid may be softened

The best anatomico-surgical method support over an accurate individual plas

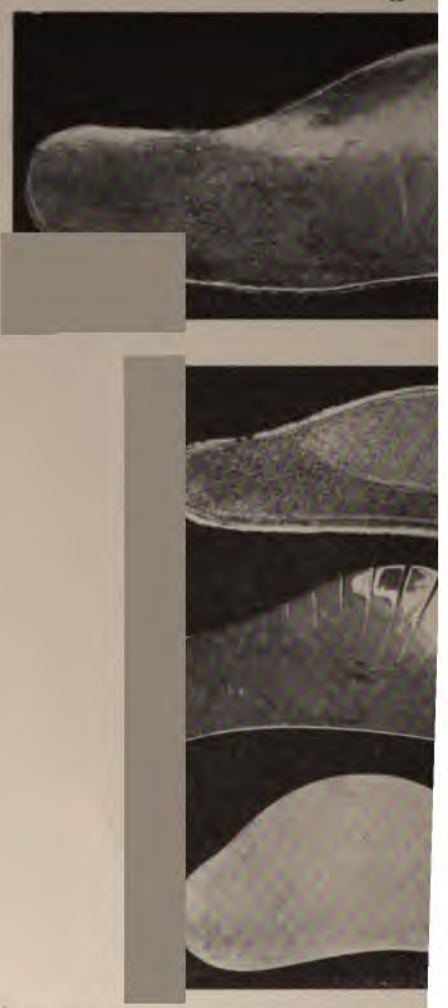


FIG. 647.—*A*, flat-foot support, with several thickn (left foot); *B*, thick felt cloth enclosed in two layers o nickel-plated steel support (left foot); *D*, celluloid arch s

Plaster Casts.—In forming gypsum with water to the consistency of very with cosmoline and placed in a box or weight shall be borne upon the foot.

[1] Trans. Am. Orth. Assoc., xiii, 1902.

[2] Wilson, Am. Med., ix, 725; Ann. Surg., xxx

The plaster mixture is then pressed about the foot until the sides of the cast are a little higher than the projecting scaphoid and astragalus; after hardening, the cast can be removed and smeared with cosmoline. From this mold a counter cast of plaster can readily be made of the lower half of the foot, giving an excellent model for the mechanic. If the foot is not sensitive, this cast can be shaved away to allow more pressure upon the weakened arch, but in the majority of cases the first plate should not be too high.

Another method is to lay the oiled foot at right angles to the leg with its outer face upon a chair, in plaster cream spread thickly upon cotton cloth. By raising the cloth an accurate mold of one-half of the foot is made. When hardened and its upper face levelled and smeared with cosmoline, fresh plaster cream is applied over the upper half of the foot. These two halves when bandaged together give an excellent and correct mold for a plaster counter-cast, which can be marked for the mechanic's guidance. Sometimes an iron mold upon which the steel plate is hammered is made for a particular case. If the plaster for the counter-cast is toughened by the admixture of five per cent. of Portland cement, an iron mold is unnecessary.

Whitman's is probably the most anatomically accurate plate, as it gives lateral support on the outer side, but is heavy and stiff and apt to cause soreness if carried as far forward as the tip of the fifth metatarsal. Such tenderness interferes with the mechanical retention of the apparatus, the object of which is by leverage to throw the foot toward the outer side in walking.[1]

The majority of the ready-made flat-foot supports are arched entirely too much along the outer border, throwing the foot into an unnatural position which is distinctly injurious. The normal sole should rest upon the ground throughout its entire outer border. Other foot-plates of instrument makers are simply steel stiffenings of the sole, obviously detrimental to muscular development.

Holland half soles and Anatomik and Sorosis R shoes, with heels extending beneath the inner arch, are the most comfortable of the ready-made appliances.

Operative Treatment.—Operative treatment for flat-foot is discussed under Rigid Foot.

RIGID AND PAINFUL FLAT-FOOT.

Rigid, deformed and valgic flat-foot due to tarsitis from extreme yielding of the arch, or to traumatism or to rheumatic gout, is often so severe as to entirely disable the patient and compel the use of crutches. The astragalus is partially dislocated from the calcaneum, as is also the scaphoid from the astragalus. These bones project downward so that a large portion of the weight of the body is thrown upon them in walking. The articulations of all the tarsal bones are distorted and tilted; the anterior part of the foot is thrown outward into positive valgus and the result is a tarsus so much deformed that it seems a rigid mass of painful

[1] Whitman, Orth. Surg., 3d Ed., 701.

The deformity is increased by the spasmodic and per-
of the peroneals and calf muscles.
ıronic sprains and injuries of an already weak foot may
condition and will require the same treatment. This
)nly in adolescents and adults.
)ports offer but little hope of relief in rigid foot, as
rease the pains by pressure. Soft felt cushions beneath
)r hair or rubber soles, the application of cooling lotions
night, high-frequency current, hot-air baking, massage
: as far as possible of weight bearing, will give relief.
t refuse operative treatment, a broad band of adhesive
)m above the outer malleolus beneath the foot and up the
leg, during adduction, is of use, especially if the tarsus
additional plicated adhesive strips. A gypsum bandage
ıkle brace or a sloping sole will also give comfort.
:atment.—(*a*) TENOTOMY of the peroneals and FORCIBLE
is the most hopeful method of cure. This forcible correc-
)ver a narrow wooden block (Fig. 619, p. 680) should be
ıe foot is fully and freely flexible and all fibrous and bony
up. The force to be applied in youths is sometimes
ief productive element in the deformity is often found in
the tendo-Achillis, the dorsal flexion of the foot beyond
eing thereby prevented, as described on p. 698. TENOT-
)O-ACHILLIS is the final and important step to overcorrec-
greatly in giving the normal dorsal flexion at the ankle and
ıent strain upon the plantar tarsal ligaments. An X-ray
ıe taken to determine if possible the cause of the difficulty.
ıt troublesome cases of rigid feet occur following tarsal frac-
ıuma. If the X-ray shows superabundant callus or exosto-
d by open operation. After overcorrection the foot is fixed
in the position of varus for four weeks, which will relieve
-continued and patient massage, active and passive move-
ular gymnastic development of the tibials must be instituted
5). A supporting flat-foot spring (Fig. 647) and sloping
essary for a long time. A steel ankle brace with pad at
s is useful. Great rigidity and sensitiveness of the tarsus is
ı in arthritis deformans in connection with the same disease
)ns of the body. If we could rid the medical profession of
the majority of these painful rigid feet are due to rheuma-
ld greatly benefit many sufferers. These feet, restored to a
)n by forcible correction under ether, will be relieved of pain,
vill be improved. Subsequent manipulation and a sloping
the foot tread into better normal line with the leg.
ytic valgic flat-foot is treated by TRANSPLANTATION of a
muscle to the scaphoid or to the tendon of the tibialis
oot being held in the meantime in a varus position and
ixed for six weeks by plaster of Paris (p. 630).
ENDON OF THE TIBIALIS ANTICUS or of the extensor pro-
ıched and sutured to the periosteum of the scaph

scaphoid may be perforated and the tendon carried through this opening to be attached to the periosteum upon the plantar surface, after tenotomy of the tendo-Achillis.

(*d*) In severe cases a WEDGE-SHAPED EXCISION of tarsus with base downward, or a scaphoidectomy may be made, the foot being forcibly brought to a slightly overcorrected position and retained there by a fixed dressing for six or eight weeks, after which walking upon the cast may be permitted and a correct position secured. A wedge-shaped slice can be taken from the os calcis and scaphoid, or the calcaneum may be sawed through and the foot brought more nearly in line with the leg.

(*e*) ARTHRODESIS of the astragalo-scaphoid articulation is of service, combined with transplantation of the tendon of the tibialis anticus, or of the extensor proprius pollicis pedis.[1]

(*f*) EXCISION of the SCAPHOID, with suture of astragalus to internal cuneiform, interferes with the flexibility of foot, but the foot is made stronger.

(*g*) Traumatic valgic flat-foot, following angular union of fracture at the lower portion of the fibula or tibia, is best treated, after an X-ray skiagram, by an OSTEOTOMY of one or both leg bones, with forcible overcorrection of the deformity and fixation in normal position for six weeks. Massage and vigorous active and passive movements will be afterwards necessary for a long time, together with the temporary support of a steel ankle brace with pad at inner malleolus (Fig. 637, p. 680).

PLANTAR NEURALGIA. PLANTALGIA

Tenderness, pain and limping with sensitive sole are due to injury, talipes cavus, flat-foot, hammer-toe, callosities or exostoses.

Diagnosis and removal of the productive cause are of prime importance. Inflammation may be reduced by wrapping the feet at night with hamamelis enclosed in waxed paper or oiled silk, or by the local use of camphor and chloral, equal parts. Rubber heels and soles and inside cork or hair soles will relieve from jar. Exostoses must be removed.

Painful sole is a most disabling condition in SPASTIC HYPEREXTENSION of TOES, where the weight of the body is thrown unduly upon the heads of the metatarsals. Cushioned soles will relieve, but tenotomies of the tendons are frequently the only permanent cure (Hammer-toes, p. 714). Shoe pressure, callosities and corns of the sole (p. 717) add greatly to the pain and discomfort of walking and sometimes completely disable. The services of a clean skilled chiropodist once a month will give great comfort. The callosities are pared or filed away after soaking with soapsuds or a carbonate of soda solution, salicylic acid rubbed upon the area and the part protected from friction by adhesive plaster. White vaseline or other ointment applied nightly will keep the parts soft. Easy shoes are essential to prevent recurrence.

[1] Wilson, Trans. Phil. Acad. Surg., iv, 188; Penn. Med. Jour., Feb. 1905; Ann. of Surg., xxxv, 758; Amer. Med., May, 1905; Jour. Amer. Med. Assoc., 1910, i, 51.

ERYTHROMEL

In neurasthenic patients, a disturb probably of vasomotor origin, consists in feet, with swelling, heat and capillary co Mitchell[1] it is essentially a nervous dise weak foot or metatarsalgia, or plantalgia

Rest, cold bathing, change of surround tomy are indicated.

METATARSALGIA ANTERIOR

A painful condition of the anterior p duces great pain and disability, is the co or "Morton's toe." The pain is frequently passage between the anterior heads of th

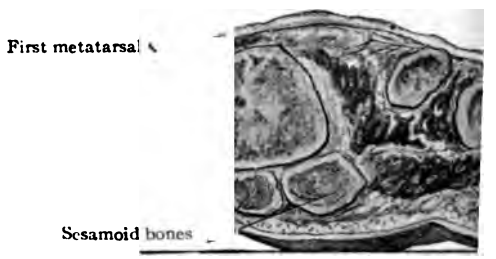


FIG. 648.—Anterior transverse arch of foot, showin (Piersol's Anato

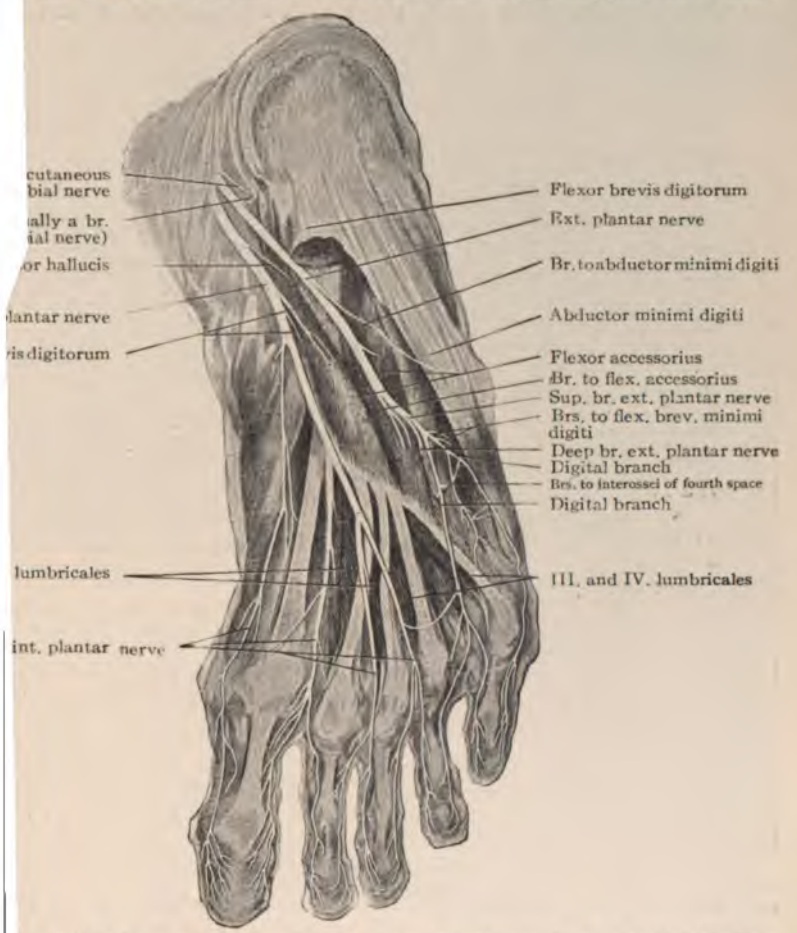
often produced, however, by the yieldin transverse arch of the foot, which norm metatarsal heads of the first and fourth t of the nerve may be upon the communic the external plantar (Fig. 649) due to the anterior portion of the foot by tight or il unknown in barefooted races. Women especially neurotics and those wearing normal position is given to the metatar mality may be found in any toe, but fourth. It may be occasioned by fractu by exostoses or by plantar neuritis. Th benumbing in character, but is often int the toe or upward to the foot and leg and with flat-foot. Removal of the shoe an quiets the pain.

Mechanical Treatment.—In these c heeled shoe should be worn, sufficiently

[1] Amer. Jour. Med. Sci., 1878, lxxvi.

[2] Goldthwait, Bost. Med. and Surg. Jour., Aug. 6, 1898; Jour. Amer. Med. Assoc., 1910, lv.

f the foot. By this plan many cases can be completely relieved. t with women, however, to accomplish such a result, as they pre- e the pain rather than wear that which is considered an unbecom- Many cases are seen where women become confirmed invalids, per shoe or a trifling operation would give speedy relief. In the anterior arch is broken down, the slight support of a wool



ection of right foot, showing internal and external plantar nerves and their branches. (Piersol's Anatomy.)

e-leather pad beneath the second and third metatarsals, together stiff-soled, well-fitting shoes, will relieve the pain. A temporary port to the transverse arch may be made by fastening such a the foot by adhesive plaster, after which a permanent bevelled is attached to the shoe, or a celluloid, aluminum or steel plate a corrected plaster cast is used. A sole sloping outward will ve relief in slight cases of associated flat-foot. Massage and movements together with improvement of the general health , as in other cases of neuralgia. Rest of the foot and the applica-

tion of lotions of hamamelis at night will
the sole and corns will require removal a
p. 717).

A similar neuritic condition may be
metacarpals are subjected to the perni
handshaking.

Operative Treatment.—In cases that
X-ray having been taken, nerve pressure
head of the metatarsal bone with a small
saw (Fig. 650). Bone forceps are apt to
deform
it is of
be upo
dons an
wound
and a t
from a
operati
of the

FIG. 650.—Metatarsal bones. Removal of the distal head of the bone relieves pressure upon the nerve and narrows the foot.

HA

Ha
a defo
turned
lanx s
angles

It
fitting
the no
side o
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advan
sure f
the e
disloca
Inflam
bursiti
condit
652). Continued irritation and neglect
ostitis, or even caries. In a gouty
pathological changes are sufficient to loc

Treatment.—During an inflammato
bed or on crutches, is of the chief impor
tions or cataplasma kaolin. Callosities
cally pared and any suppurating bursa
plasters will relieve pressure but strai
quently worn.

MECHANICAL TREATMENT.—A light
with a toe-post elevated between the firs

cases, if special shoes are constructed. Separately toed stockings (Jaeger or other) will be required. The toe also may be coaxed toward its normal position by adhesive plaster carried around a short sole-plate placed

FIG. 651.—Bunions with displacement of first phalanges from metatarsal bones.

beneath the anterior foot. A celluloid or metal splint applied at night along the inner side of the foot, the toe being drawn toward it by adhesive plaster or elastic band, will, with manipulation, render service in correction. A proper shoe, straight on the inner side and slightly sloping outward, is essential.

FIG. 652.—Bunion with first toe distorted beneath its fellows and with prominence of head of first metatarsal.

RESECTION.—In severe cases, after the subsidence of inflammatory symptoms, an X-ray skiagram having been taken, the head of the metatarsal, together with the condyle of the phalanx, may be aseptically resected. The incision should be dorsal, so as not to be subjected to subsequent shoe pressure. The bones are divided with keyhole or chain saw, as bone forceps are liable to splinter. The extensor longus hallucis should be divided and the toe straightened and dressed aseptically, without drainage, in a plaster cast for four weeks.

OSTEOTOMY.—Simple osteotomy of the shaft of the metatarsal or cuneiform osteotomy including the joint, with tenotomy and straightening of the toe will sometimes secure a good result.

AMPUTATION.—In extreme cases w
and excision of the joint are advisable.
protection of the joint will be necessa
appropriately treated.

C. H. Mayo removes the head of
bursa, turning in the membrane as a fla
plasty.[1]

Young has described bony malfor
of the first metatarsal that cause an
deformity.[2] These must be excised.

HALLUX

Hallux varus is the opposite of va
from its fellows, forming in-toe or pigec
is an accompaniment of congenital tal
will soon correct the deformity.

HALLUX RIGIDUS OR FLI

A permanently flexed condition of
with contraction of the flexor tendon, a
ally met with. The pain will be throbl
pressure from a shoe often intolerable.
is often seen in gouty subjects and will
treatment, careful attention to the loca
of muscles from flat-foot or spastic par
traumatism are frequent causes of this

Rest, a specially constructed shoe
sole support for associated flat-foot, fo
omy of flexor tendon and in severe ca
cated.

METATARSUS VARUS, OR

An angular deviation of the metat
is very common in congenital talipes
visible when the foot is in a shoe. It
sion of the anterior foot in infants; anc
lescent foot over a wooden block wh
performed.

PIGEON

Pigeon-toe may be a form of con
an inversion of toes or of metatarsus
—in varic club-foot, or an accompa
at the hips.

[1] Ann. Surg., xlviii, 190
[2] Amer. Jour. Orth. Su

A careful examination of the naked child's gait and anatomical formations is essential. Often the inversion fault will be found to be located in the rotators of the hip.

Treatment. — Forcible outward stretching of the metatarsus upon the tarsus and separate forcible outward eversion of the foot upon the leg, of the leg upon the thigh and of the thigh upon the pelvis will greatly benefit youthful cases. Voluntary external rotatory and eversion muscular movements may be associated with play in children, by attaching to a slipper with elastic cord a large rubber ball eight to ten inches in diameter (Fig. 653), so as to constitute a "return ball" when voluntarily kicked outward by the little toe side of the foot. This exercise can be performed many times in the day, the evertors of the foot, leg and hip being successively brought into play. In an orthopaedic gymnasium, foot machines for rotation, circumduction, etc. (p. 235), should be employed, or a cord and weight may be used. The child should be taught to walk with feet straight forward, or slightly everted.

FIG. 653.—Large rubber ball attached to foot by elastic strap so as to become a return-ball when repeatedly struck by foot upon the outer side. This action strengthens the outward rotators of hip and foot. When reversed and struck by the big toe it strengthens the tibials and inward rotators in flat-foot.

FIG. 654.—Spiral spring rotation apparatus for everting the feet and legs in pigeon-toe and club-foot. (Doyle.)

In talipes varus, the inversion of the anterior foot (metatarsus varus, p. 712) should be forcibly everted at the time of operation. In extreme and persistent inversion at the hip, *section of the femoral invertors*, with resection of the tensor vaginæ femoris, may be necessary. Mechanically inverted legs may be coaxed outward by Doyle's spiral spring rotation appliance (Fig. 654) or by the spiral application of a broad strip of adhesive plaster to the lower leg, so as to bring a buckle opposite the inner condyle of the femur. This buckle is to be attached to a wide strap which passes diagonally upward along the line

of the sartorius to be fastened to anoth
trochanter, and attached to a close-fitting

Another apparatus consists of a steel
of moderate eversion to a pelvic band, or
connected by a strap or elastic above the

FIG. 655.—Supernumerary toes.

supernumerary fingers (Fig. 655). The
may extend through several generation

Removal of the extra toe in infancy
A skiagram will show the bony relations.

HAMMER-TOE AND CLAW-FOOT.

Hammer-toe consists in the dorsal
extension of the first phalanx of one or
toes with sharp plantar flexion of the
phalanges.

The condition is sometimes congenit
is made worse by shoe-wearing.

CLAW-FOOT is usually accompanied b
cavus or hollow contracted foot, and the p
walks awkwardly and stiffly with no elas
of foot and often with pain from the pl
callosities beneath the projecting heads
metatarsals and above the toes (Fig.
This deformity is rarely observed until the
year, after the development of the tarsal a
found in spastic and choreic patients.

[1] Whitman's Orth. Surg.,

tendons may be mistaken for contraction of the flexors. Corns and callosities upon the soles greatly increase the pain.

Treatment.—Infantile deformity can be cured by manipulations and adhesive plaster strips. Removal of the toe at the metatarsophalangeal articulation is the only reliable cure in adolescents. If this is declined, much pain can be inflicted and little result secured by strapping and binding the toe to an aluminum or tin splint; the deformed toe however can be partially straightened by passing over it an elastic webbing strap, or adhesive strip, the two ends of which are carried beneath the other toes to each side of the foot. Tenotomy of the extensor and flexor tendons, with forcible straightening and fixation with gypsum, is unsatisfactory, as the joint surfaces are usually misshapen and ligaments contracted. Cuneiform osteotomy and resection are helpful, but amputation is preferable. Subsequent manipulations and muscular training and proper shoes are needed.

FIG. 657.—Contraction of toes, especially of first (hallux rigidus).

In CLAW-FOOT, when several toes are involved, TENOTOMY OF THE TENDO-ACHILLIS is essential in order that the foot can be more squarely brought down upon the heel and pressure upon the anterior foot relieved (Hollow-foot, p. 695, Spastic Paralysis, p. 644).

For CLEFT OR LOBSTER CLAW-FOOT see Congenital Deficiencies, p. 752. For artificial distortion of Chinese ladies' feet see Fig. 155, p. 238. Congenital hypertrophy of one or more toes is occasionally encountered, requiring amputation (Fig. 656).

TENDER OR PAINFUL HEEL.

Synonyms: Achillodynia; Achillo-bursitis; Achillo-tenosynovitis.

A number of different pathological conditions may produce a tender heel either upon the posterior or the plantar surface. The cause may be a bursitis aroused by muscular action, but more commonly it is a periostitis or an exostosis of small size, either at the posterior part of the heel or upon the plantar surface following gonorrhea. Occasionally these outgrowths will be upon the sides or at the insertion of the tendo-Achillis. Such growths are best revealed by a lateral X-ray shadowgram. They may arise either from traumatisms or from sudden muscular action, with tearing up of the periosteum and deposition of new bony matter. The increased pull upon a shortened gastrocnemius may also cause Achillodynia. Other forms of calcaneal periostitis will also give this result. In a case observed by the author, an injury, possibly excessive muscular contraction during play, had produced either fracture or calcaneal epiphysitis sufficient to cause great inconvenience, limping, and pain. The boy walked upon the outer side of the foot, and roller skating, play or a long walk would disable him for a week.

MacAlister's Anatomy says that the c centre which appears about the sixth fet epiphyseal crust which forms posteriorly fr and which consolidates about the sixteenth muscular action of the powerful gastrocnei or tear up the periosteum.

Bursitis—traumatic, gonorrheal, infec insertion of the tendo-Achillis will often pro sensitiveness and will be very disabling, es occurs. Occasionally an inflammation of don, will occur from traumatism or from in When the pain is beneath the heel it is soi and the pain will be located not only in the

Needles may be driven into the calca the patient, giving pain at each step and

CHAFED HEELS from shoe friction will disable an army on the march. Frequen ing powder, with protection by adhesive pl should be cut away, asepticized, dressed w area protected from pressure by cotton or of shoes is helpful.

Osteomyelitis and ostitis as the result quently found in children under ten. The the same as those of acute osteomyelitis i symptoms centering at the heel. The dia is marked by the violence of the symptoi soft parts and bone, it is sometimes impos of calcaneal infection except by the X-ra

Treatment.—In osteomyelitis, imme tissue through a lateral incision should diseased focus gouged, irrigated, mopped and thoroughly drained. If a sequestrui removed and a partial subperiosteal rese reproduction may be expected if the post and periosteum is saved.

In cases of tender heel that are only afforded by an outside rubber heel and a shaped to accommodate the tender plan region. A cheap inside rubber pad is sh or belladonna with acetanilid, or chloral locally will relieve pain.

Sprain and strain will be relieved by sure and partial restriction of motion can strapping (Fig. 495). Associated flat-foc (p. 705).

Gonorrheal or other exostoses, as re away level with the periosteum, the inci as much as possible subsequent weight

[1] Annals of Surgery, xlviii, 1908, 763; Jo

the shoe. In gonorrheal achillodynia the primary infection must be sought and treated. If effusion occurs, it may be aspirated. If suppuration takes place, incision and drainage are necessary.

From direct injury, or strain or partial rupture of fibres, the tendon above the heel may become tender and painful, especially on motion. Rest, adhesive plaster strapping and, in progressive cases, gypsum fixation of ankle will speedily benefit.

Sprain of the PLANTARIS TENDON, known as "tennis leg," may occur with or without rupture and should be similarly treated.

If RUPTURE OF THE TENDO-ACHILLIS or of the GASTROCNEMIUS occurs, it should be at once sutured with chromicized gut and the foot fixed in an equinus position for four weeks, after which gentle massage and muscular movements will be necessary.

Tarsal Exostoses. - Exostoses, or periosteal thickening with tendinous or connective-tissue inflammatory deposits, occur also from traumatism (Fig. 658) or from friction of the shoe, especially upon the DORSUM OF THE TARSUS.

FIG. 658. [illegible] exostoses.

A change of shoe from the laced to the buttoned variety, or *vice versa*, or the introduction of a pad of wool or felt or leather will often relieve. Rubber or cork heels and soles will assist. If the X-ray shows a positive projection that has become painful, it may be chiselled away, the skin being drawn aside during the incision to relieve the cicatrix from subsequent pressure. Friction of the shoe over any of these points especially in soldiers on long marches, is very disabling and should be prevented by daily cold bathing, disinfection with alcohol, powdering or anointing and protection by adhesive plaster as already described.

CORNS (CLAVUS), AND CALLOSITIES.

Corns and callosities are the bane of all club-feet, distorted toes, spastic and other diseases of the feet, or of any patient compelled to wear apparatus. Forming first as a callosity from moderate intermittent pressure of the shoe upon the upward growth of epithelial cells from the papillary layer, a cone-shaped mass of hardened tissue, designated as the "pin," presses upon the sensitive papillæ beneath, causing exquisite pain and often entirely disabling the patient without the cause being recognized. The pain from this pressure may be located at the special point, or may radiate to other nerve filaments, giving lancinating neuralgic pains most severe in character. Atrophy of connective tissue follows and a bursal cushion sometimes forms, connecting even with a joint-bunion (p. 711).

A small perforating ulcer may be mistaken for a corn, especially when the edges are thickened.

Treatment.—A properly fitting shoe i
corns cannot be cured if pressure is conti
obtained by soaking the area in hot soaps
of soda or liquor potassæ, and then pari
hardened epithelium with corn file or sm
corn plaster or covering of adhesive pla
protection against friction. Carbolated v
under gauze or waxed paper is the simples
ing application. The hardened tissue can
saturated solution of salicylic acid applie
the apex of corn can be lifted from its be
cylic acid in collodion is also useful if appli
carbolic acid applied to the centre of the
If blood is accidentally drawn in paring,
infected and sterile gauze or adhesive plas
sclerosis or diabetes extreme asepsis is
tion of a skilful, clean chiropodist is as ess
feet as is a dentist for the teeth. Inflamm
rest and hamamelis or boric-acid applicat
If a bursitis develops beneath the corn, th
and cataplasma kaolin or flaxseed-meal p
solution, 1:1000, the sac opened and ex
should be closed by suture.

CALLOSITIES upon the sole or at poin
the source of great suffering, the pain
patient does not discover the cause. The
should be persistently employed. A crac
gives intense suffering, the pain at night b
that will banish sleep. The hard edges
poultices, then pared away and a free ap
cotton held in place with a large pad of
packed each morning between the stocki
point of apparatus will lessen pain and
10 per cent. solution in gutta percha, or
dion, are also remedial. Silver nitrate, io

SOFT CORNS between the toes are th
of the epithelium, and give rise to mu
relieved by removing all the loose epithe
with a twenty-grain solution of copper s
toes with cotton or wool. Carbolated or s
or carbolated petrolatum will give much

PERONEAL TENDON

The peroneal tendon may be thrown
by violent muscular action, or by a slo
Occasionally the posterior tibial tendon
cases the pain and disability are positiv

In acute injury the tendon should l

position by chromicized gut, a flap of fascia being also stitched across as an additional bridge of strength.

In habitual displacement, if a brace is not required by coexistent deformities, a similar operation may be performed. The foot should be fixed in overcorrection for six weeks, followed by moderate gymnastic exercises.

PERONEAL TENOSYNOVITIS.

A strain of the peroneal tendon as it passes behind the outer malleolus may be followed by a painful tenosynovitis.

This accident may be relieved by rest and by fixation of the ankle in an everted position. The pain and disability, however, are apt to return on slight provocation and become a source of much annoyance to the patient.

After the subsidence of the inflammatory symptoms, the heel and sole of the shoe should be raised on the outer side, to relax the tendon in walking.

INGROWN NAIL.

Ingrowing nail is a most painful condition and if long continued may so demoralize the nervous system that it will take months to restore the normal tone after operation.

The condition is usually produced from shoe pressure upon a nail, usually of the first toe, that has been improperly cut back at the angles. Nails should always be trimmed straight across. The lateral edge of the nail pressing upon the sensitive nerves in the granulation tissue gives exquisite pain.

Treatment. When the nail first presses it may be weakened at the centre by scraping and the edges raised by the daily insertion of a bit of cotton pushed in with a flattened end of wire or probe, this elevating power being continued until the whole side of the nail is lifted and the nail made flat laterally. Pain may be lessened by cocaine or liquid carbolic acid, the latter being an excellent analgesic. Red oxide of mercury and orthoform are of slight but uncertain value as long as the arched edge of the nail continuously irritates the granulations. Various devices have been contrived for forcing back the granulation tissue from the nail. A small longitudinal pad, with adhesive plaster strip, or a silver wire carried under each corner and side as a bridle and retained on the dorsum of the toe with adhesive plaster or metal clamps, are sometimes helpful but are painful under shoe pressure.

Operation. Operative procedures are the most satisfactory. One or both borders or the entire nail may require removal. In children general anesthesia is advisable, but in adolescents the local sequestration and infiltration method is preferable (p. 21). The toe is surrounded with a rubber band and a sterile 1 per cent. solution of cocaine, eucaine or stovaine injected with hypodermic, thoroughly infiltrating the sides and dorsum of the toe. In a few minutes the deformed nail may be slit back far beyond the matrix and the entire lateral overriding mass of infiltrated tissue and the granulations cut away. If both sides of the nail are diseased it is better

CHAPTER X

CONGENITAL MALFORMAT

CONGENITAL malformations of the j
GENITAL DISLOCATIONS, but as a rule th
formation of one or both of the bones w

CONGENITAL MALFORMATION WI

This deformation is characterized b
upper end of the femur upon the ilium
of the acetabulum and of the head a

FIG. 659.—Double congenital malformation of a

Fortunately, the condition exists in only
Eighty-five to 90 per cent. of the cases
is less frequent than single in the proport
ous and more difficult to reduce.

CHAPTER XXIX.

CONGENITAL MALFORMATIONS OF THE JOINTS.

Congenital malformations of the joints are usually described as congenital dislocations, but as a rule the dislocation is the result of a malformation of one or both of the bones which enter into the articulation.

CONGENITAL MALFORMATION WITH DISLOCATION OF THE HIP.

This deformation is characterized by a greater or less mobility of the upper end of the femur upon the ilium and is really a malformation both of the acetabulum and of the head and neck of the femur (Fig. 659).

Fig. 659.—Double congenital malformation of acetabula and head and neck of femurs.

Fortunately, the condition exists in only a fraction of 1 per cent. of births. Eighty-five to 90 per cent. of the cases occur in girls. Double dislocation is less frequent than single in the proportion of one to two, but is more serious and more difficult to reduce.

FIG. 660.—Disappearance of roof of acetabulum with
Other hip

FIG. 661.—Malformed acetabula a

Description and Pathology.—The accompanying skiagram (Fig. 660) shows that the upper border of the acetabulum is a shelving surface instead of presenting a roof or ledge to support the head of the femur and offers little if any resistance to the upward travelling of the head. The retention of a rounded body like the caput femoris in such a cavity may be likened to the attempt to retain a smooth round object in a saucer placed on edge, rather than in a cup. Both muscular action and weight bearing tend to steadily carry the head of the bone upward upon the ilium, and the Röntgenograms show the head of the bone deformed or diminutive and the neck shortened, malformed or twisted (Fig. 661). Shadowgrams usually show not only a deformation of the neck (Fig. 662), but also its obtuse angle with the shaft, resembling coxa valga. An anteverted head pressing on the plastic acetabular roof may prevent its development and permit dislocation.

FIG. 662.—Boy 8 years old. One hip normal, the other congenitally dislocated, with valgic condition of neck.

At birth the malformations of acetabulum, head and neck probably exist, but are usually unrecognized. As muscular power increases with the child's growth, and the pressure of clothing is added to gravity in the usual flexed and adducted position of the thighs in infancy, the femoral head creeps upward. The upper rim of the misshapen acetabulum yields, the upper capsule stretches and the ligamentum teres elongates or ruptures, or the round ligament may be absent at birth. When the child begins to walk the upward movement increases until restrained by the muscles, capsule and bone, and a shallow secondary acetabulum is established on the dorsum of the ilium (Fig. 663). The original cup becomes partially filled by fibrous tissue and fat, interfering with replacement. The muscles shorten to accommodate themselves to the new position and equilibrium is maintained in double dislocations by a forward tilting of the pelvis, with consequent marked lordosis (Fig. 664). In single dislocations the pelvis

is tilted laterally and the adductors, the ha
are shortened, while the obturators and geme

Positions.—The head of the femur usu
more rare forms are the anterior (Fig. 66
ment of muscles and of equilibrium takes pla
with this deformity walk with only a mode
may even perform heavy labor as porters, w

FIG. 663.—Secondary position of head of femur in an adolescent.

to the fact that the female sex is higher

Allis explains that the femurs, being
therefore more obliquely placed in the ut
upward displacement and absorption of a

Lack of AMNIOTIC FLUID OR BANDS
also act as causes. Many theories ha
rational one indicates an error in develo
stituents of the joint (Fig. 666).

ARRESTED OR PERVERTED DEVELOPM
of control over the process or to some lo
traumatic and musculo-nervous theori
as plausible, but none are positive.

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[1] Nichols, Trans. Amer. Orth.
[2] Allis, Trans. Amer. Surg. As
[3] Amer. Jour. Orth. Surg., Fe

influence in the production of this defect, as has been noted in a number of instances. Violent traction by a blunt hook on the flexed thighs during parturition may produce a true dislocation that escapes notice at birth, and is later denominated congenital, although really traumatic.

Fig. 664. — Double congenital dislocation of hips. Trochanters above Nélaton's line. Femoral heads on dorsum of ilium. Marked lordosis of spine.

Symptoms and Diagnosis.—For examination the child should be naked. Frequently the shortening is not noticed and may even not exist until the child begins to walk, at which time progressive limp appears as the head slides upward on the ilium (Fig. 667). In such dislocations the prominence of the trochanter, its position high above a line drawn from the tuberosity of the ischium to the anterior superior spinous process —Nélaton's line—(Fig. 300, p. 351), the shortening and atrophy of the thigh, the elevation of the nato-femoral fold and the limp with moderate lordosis[1] are usually sufficiently diagnostic, even without the aid of the X-ray. The normal position of the head outside the femoral vessels in the groin will be found vacant on rotation of the femur, while the head can be distinctly felt in its posterior upward position, especially if the thigh is hyperextended or rotated. In a majority of cases the head can be moved on the ilium. In double malformations (Fig. 668), the symptoms already stated will appear, with the waddling duck-like gait and the extreme lordosis, together with widening of perineum and undue mobility of the heads. In one-sided malformations the lordosis is less (Fig. 669). The X-ray will disclose the position of the head very fully, but several shadowgrams at different angles and positions of rotation should be taken. Congenital malformations appear early; coxa vara late. In the latter condition a skiagram will definitely show the right-angled position of the neck (Fig. 267, p. 310). Early hip disease will show rigidity in place of mobility, thickening about the joint, atrophy of limb and pain (p. 464). Obscure infantile spinal palsy will give atrophy of muscles, laxity of joint, perhaps distortion of

Fig. 665.—Anterior dislocation of right femoral head.

[1] California State Journal of Medicine, Feb., 1905.

FIG. 666.—Poorly developed and malforme
hip

FIG. 667.—Upward dislocation of he

the neck and weakness of locomotion. The lordosis of lumbar spinal caries will show rigidity of spine (p. 407), with hips unaffected.

Treatment.—(I) Extension by weight and pulley; (II) corsets and apparatus; (III) forcible immediate manipulative reduction; (IV) mechanical reduction; (V) open operation.

I. Extension by weight and pulley.—Continuous strong extension for months or years, followed by efforts at reduction, have been tried for half a century and in a few cases with good results, as in Buckminster Brown's case.[1] This method is still of advantage for patients who have passed the limit of age for immediate reduction; and is of use also as a preliminary to manipulative interference in cases over ten or twelve years of age.

FIG. 668.—Double congenital dislocation of femurs, with trochanters visible high up on dorsum of pelvis, far above Nélaton's line. Lordosis marked.

II. Corsets or leather or felt pelvic supports are of some slight benefit, particularly for adult cases (Fig. 392, p. 453).

III. Forcible immediate manipulative reduction.—This method, advocated by Brodhurst and Post, systematized by Paci, and popularized by Lorenz, has established its position in the surgery of young cases. If the existence of the deformity could be diagnosed at birth, reduction of a slight departure from the normal position would probably be easy, but its retention would be difficult, as even in the newborn the acetabulum would be found defective with a nearthrosis above the normal socket.

Age for Manipulative Reduction.—The operation should not be undertaken before two years of age. The third year is the period of election, or from three to six. Lorenz prefers to wait until three years when diapers can be dispensed with, and also from the fact that muscular action is then sufficient to assist in permanent stability. Ridlon, Wilson and others believe that although reduction is easier at an earlier age[2] yet that functional results are not so good. Manipulative interference should be tried in unilateral cases up to the age of ten or eleven years (Fig. 670). Some authors claim that unilateral cases, even up to fifteen years, can be reduced if previous long continued extension is employed to relax the muscles. Double malformations are much more difficult and success is rarely attainable after seven years of age without open section (Fig. 671). Efforts at redressement must not be too violent or too prolonged. The shortness

[1] Trans. Amer. Orth. Assoc., 1891, 308; Bost. Med. and Surg. Jour., 1891.
[2] Amer. Jour. Orth. Surg., ii, 219–263.

of the trochanteric and other muscles an
important factors in determining the a
Rigidity or ankylosis is likely to follow in
have developed too high a grade of inflamn

The immediate replacement of the h
under complete anesthesia is a method r
requires excellent judgment of the surgeon
and in the wise employment of force in hi
often resulted in accident. In double dislo
able after the age of seven or eight but in si

FIG. 669.—Single dislocation of hip. Lordosis moderate.

angular wooden block four by five by nine
square sand bag, a low stool, skeins of w
673) and (Fig. 448, p. 494) sheets, cott
tenotomes (Fig. 584, p. 646). The who
case tenotomy becomes necessary or in
Four assistants are needed, one for ether,
traction and another to make counter trac
forcible reduction is accomplished by f
extension, the limb is fixed in extensi
massage and development of muscles.

[1] Amer. Jour. Orth. Surg., 1907, v. No.
[2] Willard, Immediate Forcible Reductio

Lorenz, frequently results in an anterior upward TRANSPOSITION rather than in reduction.[1]

(*b*) The method of LORENZ is incorrectly denominated bloodless (unblutigen) since it is only apparently bloodless because of the fact that the profuse hemorrhage caused by tearing all the periarticular muscles and structures, is concealed from view beneath the skin.

FIG. 670.—Congenital dislocation of left hip with shortening and eversion of leg.

The procedure consists in (1) forcible abduction; (2) forcible hyperflexion; (3) forcible hyperextension backward; (4) forcible traction downward, horizontal extension; (5) forcible abduction over a wooden fulcrum or surgeon's fist; (6) forcible rotation of the femoral head to enlarge the socket; (7) fixation of the thigh for months with the femur in outward rotation, with hyperabduction at a right angle to the body and slightly posterior to the median lateral line; (8) voluntary locomotion, with weight bearing to produce a socket; (9) massage and muscular development education.

[1] Davis, Amer. Med., Aug. 29, 1903, 352.

1. Forcible abduction, w
of adductor muscles.—Tenotor
is better than tearing them from their in
tion, except in very young children.
chopping motion of the ulnar side of th
is strongly abducted (Fig. 674). The i
an assistant while the surgeon manipu
time may
simultane

Fig. 671.—Double malformation of hips with trochanter visible near crest of ilium. Marked lordosis in the effort to maintain equilibrium.

2. H
brought
extended
hamstrin
3. H
Backwar
psoas and
muscles
placed pr
4. F
ward.
made by
in cases
traction
head to
safeguar
above th
of yarn u
without
counterti
sheet pas
well pad
adductor
condyle
5. F
Woode
Surgeo
block rou
best fulc
and the
is used
p. 733). In young children the fist of th
the slip of the femur into the socket is e
the surgeon. A test of reduction is cl
of the leg upon the thigh by tension o
straightened and while the femur is in
however, is not a reliable one.[1]

6. Enlargement of Socket
the head of the femur are used as a re

[1] Willard, Immediate Forcible Red

stretch the capsule. The folded capsule is frequently one of the chief obstacles to reduction.

After these manipulations the limb is brought down in a straight line with the body and if the head tends to be drawn back to its former position, further stretching of muscles is necessary.

7. Fixation Dressing.- The permanent fixation of one or both thighs in the right-angled abduction position, slightly posterior to the lateral median line, is necessary for many months (Fig. 678). A tightly fitting tubular stockinet jacket is applied to the body and legs of sufficient length ultimately to turn over and to enclose the plaster cast. A longitudinal permanent strip of bandage is inserted beneath the stockinet from thorax to the knee for future cleansing purposes. The child is then placed

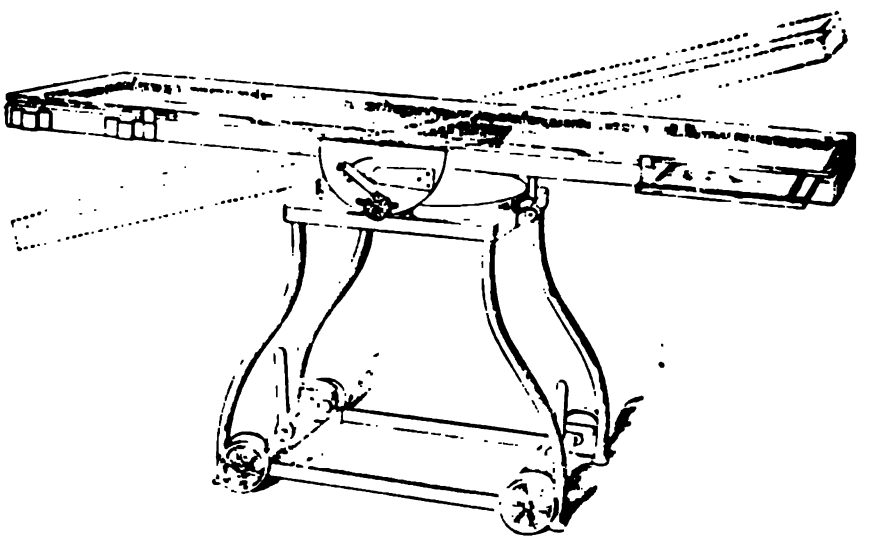

Fig. 672. Author's operating table.

on a pelvic support[1] (Fig. 673), the pelvis and thighs enclosed in cotton wadding retained by a flannel bandage. The plaster bandages are rapidly applied as spicas, holding pelvis and one or both thighs in rigid position. The genitals are temporarily included in the dressing. The pelvis to the lumbar region, and the limb to the flexed knee, are enclosed (Fig. 678). The casing is made thick and heavy, and when partially hardened it is trimmed widely from the genitals and anus (Fig. 678). The cast after drying is shellacked and covered with the surplus stockinet. Absorbent cotton is packed about the lower posterior border and extreme care used as to cleanliness. This first-position cast should be worn for three to four months until cicatrization will assist in retention of the bone in the new socket.

8. Voluntary Locomotion and Weight Bearing.- As soon as the tenderness following the operation has passed, the child is en-

[1] Pelvic Support, Willard, Ann. of Surg., xxxi, 643; Trans. Pan Amer. Surg. II, 141.

couraged to use the limb, and slight
rotating the limb gently within the
from the knee. The child will soon
cases assuming the position shown
move about on a low-wheeled chair
is sometimes worn.[1] At the end
removed, and if the X-ray shows
cast is applied, with the thigh brou
flexion of 135° (Fig. 679). The bl
reduced in height. If the head has

FIG. 673.—Pelvic support clamped to table for application of plaster dressing.

at the second dressing of a one-side

Surgeons differ as to the advisab
immobilization period, many claimin
the femur to hollow out an acetabulu

9. Massage and Muscula
moval of the final cast, massage and g
essential for a long period of time. T
until convinced that locomotion wi
critical period is for a year following t
without support, as the head may slow

[1] Davis, Amer Jour. Orth. Surg
[2] Secchi, Trans. 4th Cong. Nati

FIG. 674.—Forcible abduction with tenotomy or tearing of adductor muscles of thigh. Pelvis held firmly.

FIG. 675.—Forcible hyperflexion of thigh to stretch posterior muscles at hip. Leg held straight at knee in order to stretch hamstring muscles.

FIG. 676.—Forcible backward extension to stretch anterior muscles and tissues.

FIG. 677.—After head of femur has been drawn to level of acetabulum by horizontal traction, forcible abduction is made over a triangular wooden block as a fulcrum. The surgeon's fist may also be used as a fulcrum, with the thigh as a lever, to lift the head of the bone into the socket.

ation or slip upward and the anterior or "tr
permanent; a very common and unfortunate r

FIG. 678. — Plaster-of-Paris fixation of pelvis and thighs after reduction of double congenital malformation of hips (second dressing position).

The
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mer
its
and
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enc
by
gyr
to

Great benefit will result from exercise in gymnasium (Fig. 152, p. 235). This treatn a year. The child may move about during the day but at night should sleep in a moderately abducted cast.

Allis reduces luxation by fixing the pelvis firmly to the floor with hooks and bandages. After bringing the head by horizontal extension to the level of the acetabulum he flexes the thigh and lifts it into position by upward traction and manipulation as in a traumatic dislocation.[1] Davis and others also use the flexed position and lift the head. Willis[2] in order to avoid accidents advises several moderately severe attempts at reduction, the limb between each operation being fixed in abduction to relax the adductors and bring the head of the bone nearer the acetabulum. He encounters, however, the same difficulties experienced by other physicians; namely, the shallowness and malformation of the socket and the subsequent difficulty in keeping the head in place after walking is recommenced.

HOFFA REDUCTION METHOD.—The Hoffa reduction method consists in intermittent forcible pump-handle abductions and rotations to stretch muscles and capsule. The thigh is then flexed, slightly rotated inward and the thumb or fist employed to lift the head to the site of the acetabulum.

IV. Mechanical Reduction.—In resistive cases, mechanical power may be tension, a pad in the perineum with upward

[1] Allis, Trans. Amer. Surg. Asso
[2] Willis, Jour. Amer. Med. Assoc

assistant, and downward traction made by another assistant by a skein of woollen yarn surrounding the thigh above the knee, is the safest. If insufficient, the power of a block and pulley is added.[1]

A favorite Boston apparatus[2] is one which is claimed to lessen the danger of fracture. A sacral plate and perineal and side rods fix the pelvis. Abduction and traction are made while a rod is used as a lever to force the head into the acetabulum (Fig. 684).

Hibbs fixes the pelvis to a table, extends the leg at the knee and flexes and adducts the thigh strongly on the abdomen.[3] He then places a pad worked by a worm-screw against the trochanter, forcing the head upward into the acetabulum. The leg is afterward fixed with plaster.

Mencière argues that the reduction is best accomplished in the flexed and abducted position by the use of a long lever attached to the thigh.[4]

FIG. 680.—Low chair on wheels permitting child to move about after reduction of double congenital malformation of hips.

RELAPSE.—Relapse may be the result of the deformation of the acetabulum and also of the head and neck of the femur. When there is a poor socket, it is improbable that the head will remain in that area when it receives the weight of the body in walking. A faulty and twisted neck and head of the femur are best distinguished by taking one skiagram with limbs inverted and another everted. To correct an inversion, osteotomy below the trochanters is performed, the head being held in place for several weeks by ivory screw or by a steel nail or sharpened needle driven through skin and bone into the acetabulum.

Relapses also may occur from insufficient reduction, or from infolding of the capsule, or from fatty fibrous tissue between the head and socket and from insufficient weight-bearing movements to form a new acetabulum.[5]

V. Open Operation.—The attempts of Reiher, Poggi and others as early as 1888 led Hoffa to perfect the operation of incision of capsule with deepening of acetabulum before reduction, and Bradford has improved the method.[6]

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[1] Bradford and Lovett, Orth. Surg., 3d Ed., 497; Jour. Med. Research, Dec., 1903, v, 440; Bartlett, Amer. Jour. Med. Sci., Dec., 1903.

[2] Bradford, Amer. Jour. Orth. Surg., Aug., 1909, vii, 62.

[3] New York Med. Jour., April 25, 1908.

[4] Congrès Français de Chirurgie, Oct., 1906.

[5] Ridlon, Present Status of Operative Measures, Amer. Jour. Orth. Surg., 1910.

[6] Amer. Jour. Orth. Surg., Aug., 1909, vii, i, 57; Bradford, Bost. Med. and Surg. Jour., July 28, 1904, 85; Trans. Amer. Surg. Assoc., 1906, 175.

The open operation is indicat
whom forcible reduction has failed
sistent horizontal traction by wei
weeks before operation and the s
under ether, in advance, by strong
Absolute asepsis is imperative, the

Fig. 681.—Position of head of femur seen i

previous to the operation. An inc
femoris and gluteus medius in the
well outside of the shaft below the t
ing division of fibres. Another for
downward and backward from th
articulation through an incision be

Fig. 682. Position of femoral heads opposite the acetabula after double reduction. One acetabulum fairly good. The other shallow and deformed with very defective upper end of femur.

The fascia is divided, crucially if n
not suffice to enlarge the wound, musc
and subsequently sutured. Ordinarily
the capsule exposed and freely opene
portions being divided or cut away.
the capsular attachments to neck and
until the finger of the surgeon can pa
tion sutures having been placed in the
the ligamentum teres divided if elon
the acetabulum is definitely located, as
capsule or fibrous tissue. The openin
stretched by a strong uterine dilator.
author, the head of the bone was
found joined to the shaft only by a

FIG. 684.—Lever and fixation posts for forcible mechanical reduction of congenital dislocation. (Bradford, see p. 735.)

semi-cartilaginous union, and so small a
less. Foldings of the capsule and fibr
the lesser trochanter or inter-trochanteri
tion until they are divided. Calot adv
sule with dilatation of opening before r

The acetabulum is enlarged and d
drical ream of Doyen or Hoffa (Fig. 685
162, p. 243) until fibrous tissues, cartil
area larger than the caput. To lessen
be taken not to injure the cartilage cov
is then reduced by manipulations or ma
the new acetabulum by manual traction
special instruments.[1] The capsule is su
surgeon is absolutely certain of his asep

[1] Davis, Amer. Jour. Med. Sci., Jan., 190

drainage, but it is often safer to insert a strip of gauze for thirty-six hours.[1] Great care is necessary to prevent infection.

After replacement, the limb should be fixed with gypsum spica in the strongly flexed and abducted position for three weeks, with knee flexed and patella pointing forward as in the forcible reduction method, after which time crutches may be used. Ankylosis is so common that gentle manipulations should be made early and at each dressing, and massage manipulation and education of muscles must be continued for many months.

Dangers of Immediate Forcible Reduction.—Fractures of femur and pelvis, separation of epiphysis, rupture of vessels, tearing of nerves and

FIG. 686.—Result of manipulative reduction of one-sided malformation of hips as seen two years later.

perineum, gangrene and loss of limb have resulted, as well as death. Paralysis of the anterior crural is usually temporary, but if the sciatic is torn and not reunited, the loss of power will be permanent. Ankylosis, or stiffening, is common, and redislocation and anterior transposition are very frequent in the months following locomotion.

Fracture of the neck of the femur should be treated by fixation with plaster, in position depending upon whether reduction of the head has already been accomplished before the accident. In fractures of the shaft, the position of the plaster fixation will also depend upon the same condition (Fractures, p. 358). In fracture of the pelvis, immobilization of the limb in abducted position (p. 734) will also fix the pelvis. The X-ray will greatly aid in determining the treatment.

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[1] Bradford, Trans. Amer. Surg. Assoc., 1906, 175.

Fig. 687.—Congenital dislocation of femur red

Ridlon [2] in a consideration of one h
four forcible reduction operations rec
with 61 per cent. of change of position
In forcible manipulative reductio

called functional cures—*i.e.* in a transposition further forward but above the acetabulum—being the final result in a majority of operative cases.

The increase in successful treatment of the cases is illustrated by the records at the Children's Hospital,[1] Boston, where all cases of operative and mechanical reduction previous to 1896 were failures. From 1896 to 1902 thirty-four were treated by incision with eleven cures, twenty by manipulation with one cure. In 1902 twenty-two cases were treated by manipulation with eight cures; two by open incision, both cured. In 1903, thirty-two by manipulation, with ten cures; one by open incision with failure. From 1904 to 1906 twenty cases were reduced by manipulation and mechanical stretching, with ten cures; nineteen by open incision with twelve cures, four failures and three deaths. From 1906 to 1908 thirty-one single-hip cases were reduced by manipulation, with success in twenty-eight instances; in sixteen double dislocations, success was secured in nine; no open

FIG. 688.—Final result of manipulative reduction of single congenital dislocation of hip; see Fig. 689.

FIG. 689.—Single congenital dislocation of hip; moderate degree of progress.

[1] Amer. Jour. Orth. Surg., Aug., 1909, vii, i, 57 and 230; Best. Med. and Surg. Jour., cli, July 28, 1904.

incisions. By success was meant anatomi
the acetabulum with nearly normal funct
limp or deformity.

In the majority of the later cases th
was used to supplement manual force in
and hamstring groups and the contracte
ament. This appliance fixes the pelvis
and side posts, exerts pressure upon the
downward and forward.

Many cases of immediate manipulative
only in an anterior transposition, which
adjusted themselves to the deformity is o

FIG. 690.—Final position of head of femur two years afte
rear (see Fig.

cially in an adolescent male where strer
appearance. Permanent retention in t
rather than the rule.

The functional result and not the an
can be obtained under the circumstances,
reports from cases that were thrown into
moved upward or anterior after reductio
Subsequent efforts at depression of these
occasionally successful and in order to sec
operation is required.

Repeated gentle manipulative reduc
tearing of muscles or fractures of femur
often successful.[1]

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[1] Willis, Jour. Amer. Med. Assoc., Aug. 26
Assoc., Sept., 1907.

The third year is the time of preference. Reposition after six years is more dangerous and much less hopeful. In cases where the X-ray shows a poor acetabulum, as is the case in the majority of instances, a fixation splint should be continued for a year or eighteen months after operation, while locomotion should be encouraged by walking in the abducted position. Fig. 688 exhibits the final result obtained by forcible immediate manipulative reduction in the patient shown in Fig. 689. Figs. 690, 691 exhibit final results in one-sided dislocation; Fig. 692 in double.

FIG. 691.—Result of reduction of single congenital dislocation, seen two years later after muscle education exercises (see Fig. 687).

FIG. 692.—Result of reduction of double dislocations (see Figs. 689 and 690).

The open operation results in a better proportion of good anatomical reductions than the manipulative method, but is more likely to be followed by stiffening and ankylosis. Death follows in a larger per cent. of open operations than by manipulative procedures.

Pseudarthrosis.—In adolescents the attempt to form a new articulation by removal of the caput is unwise. A girl of seventeen, with double dislocation yet who could walk and dance with comfort, was operated on for

the author by Hoffa by open incision. I
sepsis. Hoffa reports a series of one hu
mortality, but in the two cases in which he
author in Philadelphia in 1904, one died an
longed suppuration and with permanent an

Even when complete reduction has bee
the femur placed in the site of the acetabu
does not occur until several months after wa

In patients over twelve, reduction b
although a few successful cases are reported.
age is attended with risk, and as the muscle
themselves to the deformity it is certainly q
is wise. The lordosis has become establishe
would probably result in discomfort, pain
ment of tissues.

SUMMARY.

1. Reduction under two years of age sh
2. From two to seven in double disloca
of age in single cases, reduction is possible
3. Difficult, resistive and relapsed ca
operation, although a few successful cases
are reported.
4. The open operation must be absolu
difficult to avoid ankylosis.
5. In doubtful cases, the manipulati
tempted, followed if necessary by open sec
6. Muscular developmental education i
either operation.
7. If open incision is practised, only
time.

CONGENITAL DISLOCATION O

Congenital dislocation of one or both

FIG. 693.—Congenital dislocations of both knees from faulty position in the uterus.

(Fig. 694). Retention apparatus should
begins to walk. An X-ray skiagram is us

In older and neglected cases forcible correction or resection will be required.

The PATELLA may be congenitally absent, diminutive or dislocated.

Ankle.—Congenital dislocations at the ankle are usually associated with deficiency of bone (p. 747) or club-foot.

FIG. 694.—Congenital dislocation of knee after one month of manipulative treatment and plaster casts.

CONGENITAL DISLOCATION OF SHOULDER.

A congenital malformation of the glenoid and head of the humerus is a rare condition. The glenoid will be shown by the X-ray to be defective. A dislocation discovered at birth is usually caused by traction by hook or fingers in the axilla or by some traumatism in the passage through the vagina and although denominated congenital is really traumatic. In these traumatic cases that have not been replaced immediately after birth, the paralysis, which is often accompanied by injury of the nerves, will be of long duration. (Birth Palsy, p. 651.)

The head of the humerus may lie on the dorsum of the scapula, or it may be subcoracoid, in which case the elbow is carried out from the body and the arm rotated inward (p. 652) while a bony prominence can be felt. Separation of the epiphysis or fracture may be found in birth injuries. An X-ray will assist slightly in diagnosis.

Treatment.—A dislocation, either congenital or traumatic, discovered at birth should be immediately reduced and fixed in position with gypsum (p. 553).

If a luxation is discovered later, attempts at reduction may still be safely made by manipulations and direct pressure as in ordinary dislocations of the shoulder, followed by fixation in abduction and outward rotation.[1] In resistant cases, the operative measures described on p. 556 are added, or the methods employed for old unreduced dislocations as discussed on p. 555 are used.

In cases that are causing paralysis or pain by pressure upon the nerves, resection of the head of the humerus is beneficial, the incision being made by splitting the deltoid or by an anterior or posterior incision. In the latter case care is necessary to avoid the circumflex nerve which lies along the border of the deltoid below the acromion. Paralytic cases with great relaxation of the ligaments may be cut down upon and stitched, redun-

[1] Whitman's Orth. Surg., 3d Ed., 482.

dancy of the capsule being excised. Excision of t
tional motion and use in rigid cases (Fig. 498, p.

Patient, persevering, voluntary and involunt
necessary with repeated forcible corrections of t
These methods are discussed on p. 552. Decided
expected.

CONGENITAL DISLOCATION OF ELBO

Congenital dislocations of the head of the ra
rarely found except with bone deficiencies. A sl
locating the deformity.

Supination is often impossible.[2] The deformi
to amniotic compression in fetal life, or to externa
or to defective nerve supervision of formation.

Early manipulation is indicated with gradual
by progressive casts, followed later by forcible re
with limited motion, excision of the head of the ra
may be required.

Wrist.—A subluxated or flexed position of th
jection of the radius with or without lateral devi
lung's deformity.[3] The radius or ulna may be ben
will be readily disclosed by an X-ray. Manipula
times osteotomy are indicated (Fig. 509, p. 571).

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[1] Roberts, Ann. of Surg., 1909, xlix, 431; Amer. Jour. M
[2] Powers, Jour. Amer. Med. Assoc., July 18, 1903; Hofi
[3] Archiv f. klin. Chir., Bd. xxiii.

CHAPTER XXX.

CONGENITAL DEFICIENCIES.

CONGENITAL DEFICIENCIES OF BONES

ABSENCE or deficiency of bones is not uncommon (Fig. 695). A whole or a part may be absent. The radius is the bone most frequently concerned, next the fibula, femur, ulna and tibia. In cases of fibular absence, the foot is everted to the position of valgus, owing to the absence and consequent lack of support of the internal malleolus. In tibial absence, equinovarus is found, as the internal malleolus is lacking (Fig. 696).

Deviations at the wrist will be noted in absence of radius or of ulna. Anterior displacement may occur from bending of the radius.

In femoral deficiencies, the knee is distorted so that the leg when flexed is carried across its fellow (Fig. 698). The author has seen one case

of complete absence of both upper and l
nately dying at birth. Multiple deform
limbs occu
be present
partial abs
dimpled co
is seen. Th
discloser of
Congen
with menta

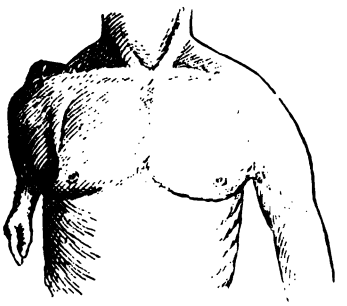

Fig. 697. — Deficiency of bones of arm and forearm with distorted hand.

Causes.

of develop
cause is suff
The most r
INAL TRAU
pregnancy,
of her condition. The violent blows on
children as they plunge into her lap ma
ovum or interfere with its nerve centres
of supervision of development. A violent coition may injure the embryo at this period as centres of ossification do not begin until the second month. If the cartilaginous provisional tissues are not formed, subsequent normal ossification will be lacking. An unusual number of provisional cartilaginous cells will result in supernumerary members. AMNIOTIC DISEASE and adhesions or bands interfere with or arrest development (Fig. 697), or may even amputate a limb.

The influence of HEREDITY cannot be doubted as recorded instances are many. MATERNAL IMPRESSIONS, except as they act upon the nervous system of the mother during the earliest months of pregnancy, can have no effect upon the fetus.

In a patient of the author's[3] with multiple deformities, the lower limbs were so shortened from deficiencies of the thigh and leg bones that the child was able to walk upon his hands with body parallel with the floor (Fig. 699). The femurs were so short that the knees were only one and a half inches from the

[1] For bibliography and complete record see Y
[2] Levi, Internat. Med. Mag., Sept., 1903.
[3] Willard, Trans. Am. Orth. Assoc., xiii, 1900, 3

buttocks were but four inches from the floor (Fig. 700). Tenotomies of the hamstring tendons and tensor vaginæ femoris with osteotomy of the deformed tibiæ raised him five additional inches (Fig. 701). The hands and feet are shown in Fig. 702. No cause could be assigned for the deficiencies.

Many cases of these deficiencies have been seen by the author, some of them capable of being benefited by various operative measures, others irremediable. He has recorded [1] a remarkable series of defective developments in the second, third, fifth and seventh children of a family in which the alternate children were normal. The parents were so ignorant that no history of previous generations could be secured (Figs. 703–712).

Atrophy of parts below the constriction, cicatricial dimples, tendency to fracture and pseudarthrosis show that amniotic bands or other constrictions often interfere with development.

Intra-uterine fractures are due to injuries to the mother later in pregnancy and to the child during birth. Such fractures often unite within the uterus, or non-union may follow with partial absorption of the fragments (Fig. 280, p. 330).

In pseudarthrosis the transplantation of fragments of bone and periosteum taken from a very young puppy or kitten may assist in securing union.

Treatment. Tenotomies and forcible straightenings and osteotomy are often helpful; plastic operations are of decided benefit. In extreme cases, and for cosmetic effect, especially in the forearm and lower leg, amputation is advisable, as it permits the adaptation of a useful artificial limb.

PELVIS. Deformity of the pelvis may occur at birth and is known as the fetal pelvis. It may be malformed obliquely or transversely by ill-directed formation or by faulty development after birth. These deformities are of great import in girls, seriously affecting subsequent labor. Irregular development and ossification of the fifth lumbar vertebra to the sacrum produces pelvic deformity, tilting of pelvis, and other irregularities. For postnatal deformities of the pelvis see Rickets, p. 280, Osteomalacia, p. 322.

ASYMMETRY

Unilateral differences of formation or of growth are common in head and face, trunk or limbs. In the head this inequality may be due to intra-cranial lesions or deficiencies (Fig. 21, p. 32). In the face, contraction of neck muscles as in torticollis, may be the cause (p. 68). In the chest or spine, malformations or absence of ribs or of vertebræ are not uncommon (Lateral Curvature, p. 254). In the lower limbs, even when [illegible] fractures of bones are present, absolute [illegible] symmetry of limbs has been shown by Roberts,[3] Hunt,[4] Morton[5] and many others, to be the exception. The variation in the [illegible]

[1] Willard, Am. Jour. Orth. Surg., [illegible] 191[illegible]
[2] [illegible], Amer. Jour. Orth. Surg., May, 191[illegible]
[3] Phil. Med. Times, Aug. [illegible], 1878.
[4] Amer. Jour. Med. Sci., Jan., 1879.
[5] Phil. Med. Times, July 10, 1880.
[6] MacAusland, Amer. Jour. Orth. Surg., May, 1910.

bones varies from one-quarter of an inch to
even when no fracture has occurred. This fac
in malpractice suits following fractures. A
absorption of the neck of the femur followin
a fracture, may give a shortening of leg an
quality of gait [1] should receive careful examir
children do not limp from habit, and a diagn
carefully differentiated from hip or knee dise
location or other condition.

[1] Tubby, Amer. Jour. Orth. Surg.,

FIG. 699.—Congenital deficiencies of lower extremities which were so diminutive that the child when in haste ran upon his hands with body parallel with floor.

FIG. 700.—Walking position of patient, Fig. 699, with buttocks only four inches from floor.

FIG. 701.—Buttocks raised by surgical and mechanical procedures until they were five inches higher than before operation.

FIG. 702.—Hand and feet of patient, Fig. 699. T

FIG. 703.—Second child of family with four children deform
(See Figs. 703 to 7

FIG. 705.—Fifth child of same family with similar deformities of hands and feet.

FIG. 704.—Third child of same family with feet and hands deformed.

Fig. 706.—Ninth child of same family with deformed hands and feet.

Fig. 707.—Skiagram of foot of ninth child.

FIG. 709.—Hands and feet of third child. (See Fig. 704.)

FIG. 708.—Hands and feet of second child. (See Fig. 703.)

FIG. 710.—Hands and feet of fifth child. (See Fig. 705.)

FIG. 211. [illegible]

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